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TRADE AND DEVELOPMENT BOARD
Ad Hoc Working Group on Interrelationship
between Investment and Technology Transfer
Second session
Geneva, 13 December 1993
Item 1 of the provisional agenda

ADOPTION OF THE AGENDA AND ORGANIZATION OF WORK

Provisional agenda and annotations to the provisional agenda

Note by the UNCTAD Secretariat

I. PROVISIONAL AGENDA

1. Adoption of the agenda and organization of work

2. Interrelationship between investment and technology transfer:

   (a) Investment flows, transfer of technology and competitiveness;

   (b) Technological capacity-building in developing countries, particularly the least developed countries, and in countries undergoing the process of transition to market-economy;

   (c) Transfer and development of environmentally sound technologies

   (The discussion will be based on the presentation of preliminary or final country case studies and other relevant reports.)

3. Provisional agenda for the final (third) session of the Working Group

4. Other business

5. Adoption of the report of the Working Group to the Trade and Development Board.

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II. ANNOTATIONS TO THE PROVISIONAL AGENDA

Item 1: Adoption of the agenda and organization of work

The provisional agenda for the second session was approved by the Ad Hoc Working Group at its 4th (closing) meeting on 29 January 1993.

A proposal for the organization of work of the second session is given in section III below.

Item 2: Interrelationship between investment and technology transfer:
(a) Investment flows, transfer of technology and competitiveness;
(b) Technological capacity-building in developing countries, particularly the least developed countries, and in countries undergoing the process of transition to market-economy;
(c) Transfer and development of environmentally sound technologies

As stated under this agenda item, the discussion will be based on the presentation of preliminary or final country case studies and other relevant reports. The UNCTAD secretariat is, therefore, circulating the country case studies in the form and language in which they were received. 1/

In response to the request made in the Work Programme of the Ad Hoc Working Group, 2/ the secretariat has prepared two reports entitled respectively: (i) "Review of the work of the United Nations system and selected organizations dealing with investment-related technology issues" (TD/B/WG.5/6), and (ii) "Fostering technological dynamism: evolution of technology capacity-building and competitiveness" (TD/B/WG.5/7).

The first report provides a review and presents a synthesis of activities on investment-related technology issues carried out by the United Nations system and other selected organizations dealing with areas of concern to the Working Group.

The second report is based on the review and analysis of literature on technological capacity-building and on the role of technology in the international competitiveness of nations and enterprises. The report constitutes an extensive summary of a more comprehensive report which will be published as a United Nations publication. The literature sources that have been consulted in preparing the review are listed in background document UNCTAD/ITD/TEC/12.

In addition to the above documents, the secretariat is also submitting the report of the Workshop on Transfer and Development of Environmentally Sound Technologies held in Oslo, from 13 to 15 October 1993, as part of the work programme of the Ad Hoc Working Group.

Item 3: Provisional agenda for the third (final) session of the Ad Hoc Working Group

A draft provisional agenda for the third session of the Ad Hoc Working Group will be submitted to the Working Group for its consideration.

Item 4: Other business

Item 5: Adoption of the report of the Ad Hoc Working Group to the Trade and Development Board

Paragraph 12 of the terms of reference of the Ad Hoc Working Group states that the Working Group shall submit a final report on the results of its work to the Trade and Development Board.

III. TENTATIVE ORGANIZATION OF WORK

Monday 13 December	10. a.m.	Plenary Opening of the meeting Item 1 and introduction of Item 2. (Interrelationship between investment and technology transfer). Informal meeting Guest speakers and panel of experts invited by the secretariat
	15. p.m.	idem
Tuesday 14 December	10. a.m.	Informal meeting Presentation of country case studies by national experts
	15. p.m.	idem
Wednesday 15 December	10. a.m.	idem
	15. p.m.	idem
Thursday 16 December	10. a.m.	Informal meeting Continuation of consideration of Item 2 and discussion of the secretariat reports
	15. p.m.	Informal consultations
Friday 17 December	10. a.m.	idem
	15. p.m.	Final plenary Item 3: Provisional agenda for the third session of the Ad Hoc Working Group Item 4 : Other business Item 5: Adoption of the report of the Ad Hoc Working Group to the Board

Notes

1/ The secretariat will attempt to circulate in one single document the executive summaries of the case studies as provided by the Governments.

2/ See report of the Ad Hoc Working Group on Interrelationship between Investment and Technology Transfer on its first session (TD/B/WG.5/4), annex I, para. 7.

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TRADE AND DEVELOPMENT BOARD
Ad Hoc Working Group on Interrelationship
between Investment and Technology Transfer
Second Session
Geneva, 13 December 1993
Item 2 of the provisional agenda

REVIEW OF THE WORK OF THE UNITED NATIONS SYSTEM AND SELECTED ORGANIZATIONS DEALING WITH INVESTMENT-RELATED TECHNOLOGY ISSUES

Report by the UNCTAD secretariat

GE.93- 53724

CONTENTS

	Paragraphs
Chapter I. **INTRODUCTORY OVERVIEW**	1-12
A. Background	1-3
B. Overview	4
1. Investment flows, transfer of technology and competitiveness	5-6
2. Technological capability-building	7-9
3. Transfer and development of environmentally sound technologies	10-11
Chapter II. **ACTIVITIES OF SELECTED ORGANIZATIONS DEALING WITH INVESTMENT-RELATED TECHNOLOGY ISSUES**	13-77
A. Organizations of the United Nations system	13-46
1. United Nations organizations and bodies	14-32
(a) Department of Economic and Social Development	14-18
(b) Economic Commission for Africa	19
(c) Economic Commission for Europe	20
(d) Economic Commission for Latin America and the Caribbean	21-22
(e) Economic and Social Commission for Asia and the Pacific	23-25
(f) Economic and Social Commission for Western Asia	26-27
(g) United Nations Development Programme	28-29
(h) United Nations Environment Programme	30-31
(i) United Nations University	32
2. Specialized and related agencies	33-46
(a) Food and Agriculture Organization	33-34
(b) International Fund for Agricultural Development	35
(c) International Labour Organization	36-37
(d) United Nations Educational, Scientific and Cultural Organization	38
(e) United Nations Industrial Development Organization	39-43
(f) World Bank	44-45
(g) World Health Organization	46
B. Intergovernmental organizations	47-64
(a) African Development Bank	47
(b) Asian Development Bank	48
(c) Association of South-East Asian Nations	49
(d) Caribbean Development Bank	50
(e) Centre for the Development of Industry	51
(f) Commission of the European Communities	52-53
(g) Consultative Group on International Agricultural Research	54
(h) European Investment Bank	55
(i) Inter-American Development Bank	56
(j) International Centre for Public Enterprises in Developing Countries	57
(k) Islamic Development Bank	58
(l) Latin American Economic System	59
(m) Organization for Economic Cooperation and Development	60-62
(n) Preferential Trade Area for Eastern and Southern African States	63-64

C. National organizations 65-68

(a) Finnish Fund for Industrial Cooperation 65
(b) German Agency for Technical Cooperation 66
(c) International Development Research Centre 67
(d) Swedish Agency for Research Cooperation with Developing Countries 68

D. Non-governmental organizations 69-77

(a) International Association of Trading Organizations for a Developing World 69
(b) International Federation of Consulting Engineers 70
(c) International Chamber of Commerce 71-72
(d) International Organization for Standardization 73-74
(e) Latin American Association of Development Financing Institutions 75
(f) Technological Information Promotion System 76
(g) World Assembly of Small and Medium Enterprises 77

Chapter I

INTRODUCTORY OVERVIEW

A. Background

1. The Cartagena Commitment, at UNCTAD VIII, marked a new departure and provided new directions for UNCTAD's work in the field of technology.1/ It requested the Trade and Development Board to establish the Ad Hoc Working Group on the Interrelationship between Investment and Technology Transfer, which, at its first session in January 1993, adopted its work programme.2/ The present review of the activities of the United Nations system and selected organizations dealing with investment-related technology issues has been undertaken in response to a request made by the Ad Hoc Working Group at that session.3/

2. In May 1993, a sample of 84 organizations, including organizations within the United Nations system, intergovernmental and non-governmental organizations, and national organizations providing development assistance, were invited by the Secretary-General of UNCTAD to provide him with information and relevant material on their work on investment-related technology issues over the past two years and regarding activities planned for 1994-1995. The organizations were asked to provide a short description of their activities, covering both analytical and technical cooperation aspects, and giving information on issues, sectors and countries dealt with, as well as the main findings of their work. They were also asked to address the three issues with which the Ad Hoc Group is concerned, i.e., investment flows, transfer of technology and competitiveness, technological capability-building, and transfer and development of environmentally sound technologies.

3. Forty-three organizations replied to the Secretary-General's request.4/ The present chapter gives an introductory overview. It is followed by a chapter providing a synthesis of the respective organizations' activities with regard to investment-related technology issues, observing, as much as possible, a common scheme, and listing organizations in alphabetical order within the respective institutional breakdown.

B. Overview

4. This section presents an introductory overview of the activities being undertaken by the responding organizations, according to the three issues under consideration by the Ad Hoc Working Group: (a) investment flows, transfer of technology and competitiveness; (b) technological capability-building; and (c) transfer and development of environmentally sound technologies.

1. Investment flows, transfer of technology and competitiveness

5. Essential components of the activities reported on in the present review concern the interrelated issues of investment, technology and competitiveness. A large number of the activities deal with research and policy analysis concerning these issues, and with the collection of corresponding data and information. This type of activity includes the research carried out on global trends within the organizations' respective mandates (e.g., DESD and UNU); issues concerning the technology and growth-promoting impact of foreign investment; or the role of foreign direct investment (FDI) in the transfer of technology, linking it to local technological development opportunities (e.g., ECA). Other important issues relate to the overall promotion of foreign investment (e.g., UNIDO and ICC); the implications of new technologies for investment and competitiveness, for example, of advanced materials (e.g., ESCWA and OECD), or the employment implications of investment flows, new technologies and competitiveness (e.g., ILO). Analytical work is also being carried out with a view to identifying the new type of technology policies required to tackle present economic challenges, for example, regional policies for increasing competitiveness and assisting in the industrial restructuring process (e.g., ECLAC). In addition, the organizations participating in the

present review reported on various workshops and seminars organized for the discussion of the above issues.

6. Though not always totally distinct, another set of activities appears to involve more action - and of a technical assistance-oriented nature, also encompassing diverse advisory services activities and training. Such activities cover, for example, a wide spectrum of financing ventures, carried out by organizations such as the regional development banks or the World Bank, or by associations of development banks (e.g., ALIDE), with each organization endeavouring to respond to the demand of its constituency in keeping with its resource availabilities. Other important activities are assistance to countries in the identification of priority areas and the formulation of specific projects for investment and technology (e.g., FAO and PTA); the promotion of inter-enterprise partnerships such as between EC and ACP enterprises; the establishment of joint ventures at the bilateral level (e.g., national organizations providing development assistance); and the creation of partnerships and exchanges between universities and industrial enterprises (e.g., the EC). The setting up and operation of databases, for instance on FDI, including related legal instruments, for example in East European economies (e.g., the ECE), constitute significant activities in this field. Regional coordination functions, e.g., with respect to industrialization or intellectual property, play a central role in the work of SELA.

2. Technological capability-building

7. Most of the organizations reviewed are involved in technological capability-building in their respective areas of competence, through assessments, studies, research, seminars, workshops, projects and training activities. The significant effort made by each organization in its own field to develop technological capacities demonstrates the importance attached to this factor for strengthening the overall technological capability of developing countries.

8. The results of these activities and information relative to regions and individual economies are disseminated in seminars and workshops, e.g., by the United Nations regional commissions, specialized agencies, and special programmes, including UNEP, FAO, IFAD, ILO and WHO, which undertake activities designed to build up capabilities in specific areas such as crop and post-harvest management, aquaculture, disease prevention, engineering, data processing, electronics and environmentally sound technologies. Research work and activities concerning new and emerging technologies, e.g., biotechnologies, micro-electronics and new materials, are increasingly being undertaken by specialized institutions that support the creation of networks at regional, interregional and global levels. Specific dimensions and aspects of these technologies are emphasized by the sponsoring organizations.

9. Human resource development activities are a central component of technical cooperation. Activities include training at the country level, involving new and emerging specific technologies, among others. They also cover issues such as foreign investment-related technology, investment in privatization and technology assessment, in both the public and private sectors. ESCAP, FAO, ILO, UNEP, ASEAN and PTA pay particular attention to training activities, while, among funding institutions, the World Bank gives priority support to training and technical education. The Bank has also helped to set up institutions for financing technological development in a number of countries, and directly funds such development in health and agriculture as well as economic research on technology-related issues. Dissemination of knowledge forms the central thrust of UNESCO's work; recently the organization has concentrated its efforts on programmes to promote cooperation between universities and industry. ESCWA and ECLAC aim at strengthening R&D institutions and their linkages with the productive sector, in addition to improving the role of industrial development banks in transferring technology. The EC Framework Programme on Research and Technological Development and the Programme on Human Capital and Mobility include education, academic exchanges and research programmes in technology-related sectors. EC technological and R&D cooperation is extended to developing countries and countries in transition with regard to health, agriculture, and industry. Apart from

project financing, regional banks assign increasing importance to technical assistance, particularly in technical project design and supervision. The IsDB also supports technological capability-building in the region through job training, scholarship programmes, and information networks in science and technology.

3. Transfer and development of environmentally sound technologies

10. The transfer and development of environmentally sound technologies has recently been one of the outstanding issues in the intergovernmental debate within a number of international organizations. Their activities are supported by research and efforts to disseminate information concerning the development, transfer and application of these technologies. Comprehensive reports have recently been prepared by a number of governmental and non-governmental organizations, while UNIDO, UNEP and ESCAP operate databases with information of particular relevance. The United Nations Conference on Environment and Development (June 1992) played a major part in attracting international attention to this issue and was followed by a number of intergovernmental meetings, notably the first session of the Commission on Sustainable Development which launched a comprehensive work programme in this area.

11. The efforts of developing countries and countries in transition to achieve sustainable industrial development are aided by technical assistance and financial support from a large number of sources. Special technical assistance programmes in this area are being implemented by UNIDO, UNEP, FAO, United Nations regional commissions and OECD, with financial support from UNDP, the World Bank, European Community, Common Fund for Commodities, regional development banks and individual donors.

* * *

12. While the present review allowed for the identification of an impressive variety of forms that investment and technology-related activities take, it is understandably difficult to grasp how evenly spread these are, or how they relate to the needs and requirements of the developing countries or of countries in transition. What emerges from the information gathered in the preparation of the review is clearly that, in a rapidly changing world in which the pace of technological change is accelerating, the need to keep up with such change, responding to increasing development needs and participating effectively in world trade require important and constantly renewed efforts on the part of the main economic actors in the field of investment and technology, such as governments, enterprises, financing institutions and the R&D community. Human resource development and the systematic search for novel and renewed forms of cooperation are key elements in these endeavours.

Chapter II

ACTIVITIES OF SELECTED ORGANIZATIONS DEALING WITH INVESTMENT-RELATED TECHNOLOGY ISSUES

13. This chapter presents a synthesis of the replies and the material received from selected organizations on the relevant work in the area of investment and technology. It is organized around the subjects of investment flows, transfer of technology and competitiveness; technological capability-building; and transfer and development of environmentally sound technologies.

A. Organizations of the United Nations system

1. United Nations organizations and bodies

(a) Department of Economic and Social Development (DESD)5/

(i) Programme on Transnational Corporations

14. The Programme on Transnational Corporations dealt with the activities of transnational corporations and their effect on a wide range of issues in the field of technology and investment.6/ The 1992 edition of the World Investment Report contained a chapter on transnational corporations, technology and growth which pointed out that the growth-promoting impact of technologies acquired through FDI ultimately depends upon the incentive structure faced by both foreign and domestic enterprises in developing and acquiring technologies. A study examining how transnational corporations from the developing countries can make a contribution to their home economies was recently published. The annual World Investment Directory publication provides analytical information on foreign direct investment flows and stocks. Numerous other publications of the Programme examine TNC activities, including technology-related aspects, from sectoral and country perspectives. Human resources development remained a central component in the Programme's technical cooperation activities. Advisory services and training activities provided training with significant emphasis on new technologies to entrepreneurs as well as to public officials of developing countries and of economies in transition.

15. In the field of environmentally sound technologies the Programme recently developed options to facilitate the transfer of these technologies to developing countries on favourable terms and undertook an extensive project on environmental accounting for sustainable development.

(ii) Science and Technology Branch (former United Nations Centre for Science and Technology for Development-UNCSTD)

16. Activities and publications of the UNCSTD (eventually Science and Technology Branch) have indirectly addressed the issue of interrelationship between investment and technology. The report on the contribution of technology to industrialization and regional and global integration, submitted to the Commission on Science and Technology for Development at its first session (April 1993), emphasized the need to integrate science and technology policies in developing countries in order to upgrade their scientific and technological base and strengthen the linkages between national research and development and private firms.

17. The Advanced Technology Assessment System (ATAS) was a tool for policy analysis and for strengthening the scientific and technological capacities of developing countries. The ATAS bulletins assessed a wide range of technologies, including microelectronics, automation, information, new materials, energy systems, photovoltaics and biotechnology. The ATAS programme addressed environmental issues in a publication on environmentally sound technology for sustainable development and in a study on energy systems, environment and development.7/ A recent report deals with energy technologies, focusing on policy issues and options for the effective transfer and application of environmentally sound energy technologies. In the area of

technological endogenous capacity-building, a number of reports have recently been prepared8/ and country projects implemented in Cape Verde, Jamaica, Pakistan, Togo, Thailand, Uganda and Viet Nam. Furthermore, a series of activities has been organized by the Science and Technology Branch in the area of conversion of industrial technology from military to civilian uses.

(iii) Mineral Resources Branch

18. A number of activities relating to technology and investment issues have been implemented by this Branch. A report on ways and means of facilitating the flow of financial resources and transfer of technology to develop the mineral resources of developing countries was presented to the Committee on Natural Resources at its first session, when a proposal was also made for a mechanism to gather and monitor information on the flow of investment in the mineral sector of developing countries, and capacity-building in investment promotion.9/ Many projects executed by the Mineral Resources Branch have financial-technical components in the context of investment promotion. For example, since 1989 a project has been assisting the Thai Government with the development of potash resources in North-east Thailand.

(b) Economic Commission for Africa (ECA)

19. ECA's work comprises various activities in the area of investment flows, transfer of technology and competitiveness. It has conducted case studies since the beginning of the 1990s on the role of FDI in transfer of technology, and on local technology development opportunities in African countries, covering information processing, food processing, petrochemicals, and negotiation techniques. In 1991, ECA presented a paper on the role of FDI in the transfer of technology through licensing agreements to a national seminar on transfer and development of technology in Burundi. In 1992, a case study in the United Republic of Tanzania on the role of transnational corporations (TNCs) in the transfer of biotechnology in Africa examined how governments could improve the mechanisms of transfer of biotechnology. A comprehensive study on FDI and manufactured exports from Africa is planned for 1994. Concerning technology capability-building, a current project on Japanese foreign investment in Africa emphasizes the development of human resources through TNC investment from Japan. ECA is preparing a study on the relationship between growth and technology transfer which will review issues and prospects involved. In the field of transfer and development of environmentally sound technologies, a case study on the transfer and development of new technologies in renewable energies in Burundi was recently published, examining the implications of TNC operations for technological development issues.10/

(c) Economic Commission for Europe (ECE)

20. Concerning investment and technology transfer, under the UN/ECE Committee on the Development of Trade, the ECE secretariat maintains a database on FDI in East European economies. A yearly survey of recent trends in foreign investment in European economies in transition was recently published. Within the framework of the Working Party on Contract Practices, the secretariat also monitors changes in legislation pertaining to FDI, including privatization legislation. A guide on selected legal questions related to these issues in the economies in transition was recently published, and the secretariat edits the"Newsletter East-West Investment News".11/

(d) Economic Commission for Latin America and the Caribbean (ECLAC)

21. ECLAC has been particularly involved in the area of investment and technology transfer through research and policy analysis, information gathering, and the organization of seminars and workshops. In research and policy analysis, the ECLAC/DESD Joint Unit on Transnational Corporations has paid special attention to the role of foreign capital in the process of restructuring under way in most countries of the region. Some of ECLAC's recent documents on the subject deal with industrial modernization, selected aspects of foreign capital and its impact on the industrial sector, the role of TNCs and the manufacturing sector, technological behaviour of national and

transnational enterprises, and industrial cooperation between developed and developing countries.12/ Most of ECLAC's material is based on case studies. With respect to information on FDI and TNCs in Latin America and the Caribbean, a restricted version of the Regional Statistical Directory was prepared. In 1992, the first regional symposium on TNCs for Investment and Development was organized.

22. ECLAC's Division of Production, Productivity and Management has analyzed the current situation and prospects of technology policies in Latin America, based on national experiences in the region, and is considering the policy issues to be tackled in the immediate future. These include the need for competition policies beyond trade liberalization, the identification of foreign investment, large domestic firms, strategic alliances as components of the Latin American agenda for technological development, and the importance of the regional and subregional integration framework for technological development.

(e) Economic and Social Commission for Asia and the Pacific (ESCAP)

23. Investment-related technology transfer issues have been receiving systematic attention from the Commission and other ESCAP legislative bodies. At its third meeting in October 1993, the Steering Group of ESCAP's Committee on Regional Economic Cooperation will, inter alia, deliberate upon a draft action programme for regional economic cooperation in investment-related technology transfer, and on the development of technological capabilities.

24. Concerning investment flows, transfer of technology and competitiveness, ESCAP has been promoting technology transfer to small and medium-size enterprises (SMEs). A Regional Investment Information and Promotion Service (RIIPS) is being considered to help enterprises, particularly SMEs, engage in industrial cooperation encouraging intraregional investment flows among capital- and technology-exporting and importing countries. Concerning legal policy aspects, the secretariat is finalizing a Regional Study on Patent Laws, Regulations and Organizational Structure. A project on promoting international competitiveness and efficient resource utilization in manufacturing is being carried out, and a seminar held in 1991 suggested that outward-looking and liberalization policies, cooperation in research and development and human resource development assisted in achieving manufacturing competitiveness. Concerning technology transfer policies, the secretariat undertook a regional study on the legal aspects of biotechnology transfer and convened a meeting in 1991 to assist in strengthening legal frameworks. At a workshop held in 1992, the establishment of an umbrella mechanism for regional cooperation in the interrelated areas of standardization, metrology, testing and quality control was envisaged. The creation of a technical consultancy development programme for the region, based on the concept of TCDC, is being considered, and the secretariat is planning a regional survey. Through the Asian and Pacific Centre for Transfer of Technology (APCTT), a system for providing quality information on technology opportunities to small and medium-scale industries, with emphasis on environmentally sound technologies (METI), and a regional on-line technology information service (APCTT OTIS) have been established.

25. In the domain of technological capability-building, ESCAP assists in industrial and technological policy formulation and reorientation relative to the least developed countries and economies in transition, such as the Asian Republics of the Commonwealth of Independent States (CIS). Policy seminars on private-sector growth, investment and technology were organized in Bangladesh and Nepal. A Seminar-cum-Study-Tour on Human Resources Development Policy and Planning for Industrial Development was held in November 1991. Other seminars on technology issues were organized in 1992 for Thailand and Malaysia, and a project on technology transfer and management for selected transitional economies was formulated. With respect to the transfer and development of environmentally sound technologies, courses were conducted within the Pacific Energy Development Programme from 1989 to 1991 in Kiribati, Solomon Islands, Maldives, Palau, Fiji, the Federated States of Micronesia and Papua New Guinea. The courses provided training and related materials on photovoltaic

systems for instructors at technical training institutions aimed at promoting technical progress and employment generation in the rural sector.

(f) Economic and Social Commission for Western Asia (ESCWA)

26. The activities of ESCWA's Science and Technology Programme in investment-related technology issues have both regional and national dimensions. Concerning investment flows, transfer of technology and competitiveness, ESCWA, in cooperation with UNIDO, IDRC and the Islamic Development Bank, recently held a workshop on the implications of new and advanced materials technologies for the economies of the ESCWA countries. Two workshop recommendations dealt respectively with resource and technological requirements for utilizing polymers, composites and ceramics, along with the decision to hold a workshop for officials in Egypt on policy implications of new and advanced technologies. The former activity has been included in ESCWA's work programme for 1994-1995. Currently, ESCWA is organizing a workshop on the integration of science and technology in development planning and management in the private and public sectors. With respect to technology capability-building, ESCWA carried out an extensive study on the strengthening of research and development and its linkages with the production sector. In 1989, ESCWA organized a workshop in cooperation with various national and regional institutions on the role of specialized financial institutions in the development of endogenous technological capabilities in the region.

27. Concerning the transfer and development of environmentally sound technologies, ESCWA has formulated a project proposal to establish a regional network of experts and institutions on technology assessment and forecasting in that field, including all the developed countries with which ESCWA countries have extensive trade and technology transactions. ESCWA's work programme covers activities concerning the protection of the ozone layer, including training courses for engineers, technicians and managers on the rationalization of the production and use of substances harmful to the ozone layer. A regional science and technology network is being established, with the cooperation of regional and national institutions, to survey government departments and NGOs concerned with science and technology for development.

(g) United Nations Development Programme (UNDP)

28. UNDP contributes financing to science and technology, and to mineral exploration projects as well as feasibility studies and geothermal energy through the Fund for Science and Technology (UNFSTD) and the Revolving Fund for Natural Resource Exploration (UNRFNRE). The overall UNDP-framework of capacity-building for human development focuses on national training programmes, assistance in policy formulation, and institution-building in the areas of environmental problems and natural resource management, management development, and the transfer and adaptation of technology.13/ UNDP also supports national programmes to promote partnership between the private and public sectors.

29. One of UNDP's instruments for the follow-up to UNCED is Capacity 21, a framework for national programmes that aims at capacity-building for managing the environment and natural resources in the context of economic and social development. The activities under the programme are intended to strengthen the decision-making process and to facilitate better access to information, greater awareness, knowledge and participation concerning the underlying issues. Launched in 1993, the programme is currently being implemented in 10 countries; for 1994, further activities are planned in another 15 to 20 countries. Within the Global Environment Facility (GEF), where UNDP participates as one of three implementing agencies, a comprehensive work programme has been developed for financing investment-related technologies which lead to reduced greenhouse gas emissions, conservation of biological diversity, cleaner international waters and conservation of the ozone layer. During the three-year pilot phase of the GEF (1991-1993), UNDP is managing a work programme of 55 GEF projects valued at US$242 million, including 23 global warming projects, 23 biodiversity projects, 8 international waters projects and one ozone-related project. In addition, UNDP is undertaking 19

pre-investment studies valued at US$17.6 million and a small grants programme now operational in 33 pilot countries.

(h) United Nations Environment Programme (UNEP)

30. UNEP's main activities in the field of investment-related technology issues concentrate on the transfer and development of environmentally sound technologies. Increasing emphasis is given to the implementation of Agenda 21, which provides a significant opportunity to integrate developmental and environmental considerations into a programme of specific projects to support sustainable development. The Earthwatch programme, coordinated by UNEP, is to play a significant role in the work of the Agenda's implementation by helping to identify emerging environmental problems, assess risks and issue early warnings. The programme is to expand its cooperation with private and non-governmental research institutes. UNEP's tasks include the dissemination of environmental information to governments and other bodies of the United Nations system through its cooperation with, inter alia, FAO, WHO, UNESCO, IUCN and OECD, coordinating scientific and research activities directed toward sustainable development issues.14/

31. The UNEP Governing Council places high priority on strengthening UNEP's contribution to science for the management of sustainable development. At its seventeenth session, it called for stronger measures to encourage technology transfer through UNEP's Industry and Environment Programme Activity Centre in France, and the recently established Environmental Technology Centre in Japan. The Centre in France provides a clearing house function through its "OzonAction" programme, while UNEP's Cleaner Production Programme facilitates the transfer of technologies and management tools that reduce emissions at the source and conserve raw materials and energy.

(i) United Nations University (UNU)

32. The UNU's Institute for New Technologies (INTECH) is a research and training centre devoted to the economic and social aspects of new technologies. It seeks to improve the understanding of the implications of new technologies for development strategies and industrialization policy, the influential factors in the diffusion of new technologies to developing countries, and the impacts of new technologies on socio-economic variables such as output, trade, employment and distribution of welfare. Besides research and advanced academic training, INTECH's tasks comprise information dissemination. While currently focusing principally on micro-electronics, INTECH intends to broaden the scope of its work during the 1994-1995 biennium, to cover the development role of biotechnology, the implications of new technologies for environmental quality and sustainable development, and the problems and opportunities presented by the combination of new technologies and institutional reforms in Eastern Europe. INTECH also intends to contribute to the work on the interrelationship between investment and technology transfer.

2. Specialized and related agencies

(a) Food and Agriculture Organization (FAO)

33. FAO has been operating country-level and regional field projects which have strong research, technology transfer and development components. In the field of transfer of technology, it is preparing a conceptual framework, guidelines and indicators relating to assessment and transfer of technologies for sustainable agricultural and rural development. With the support of UNDP, FAO is liaising with five international agricultural research centres of the Consultative Group on International Agricultural Research (CGIAR) for providing more complete information on the choice and application of mature/proven technologies at the global level. The Investment Centre has assisted selected member nations in formulating proposals for public investments in technology generation and transfer in agriculture and natural resource management, mainly to create or strengthen national R&D institutions. Proposals for private investment take the form of credit components to allow the introduction of more cost-effective technologies or systems of operation.

The FAO Commission on Plant Genetic Resources is considering a code of conduct for transfer, development and use of biotechnology in issues relating to intellectual property rights and bio-safety. Regional bio-informatics networks have been established in Asia, the Pacific, Latin America and the Caribbean. A recent publication entitled "Bio-technology in Agriculture, Forestry and Fisheries" set out policy guidelines for the development and use of biotechnologies.

34. In technology capability-building, policy assistance is being provided to member countries regarding technology choice, priority setting, linkage and application of new technologies. FAO is assisting in linking private and public sectors, especially as regards in vitro culture of virus-free planting material, with a view to strengthening cooperation among developed and developing countries in modern biotechnologies, and the development of human resources, research infrastructures and joint ventures through regional networks and programmes in Asia and the Pacific and Latin America and the Caribbean. FAO is also helping developing countries, especially in the Near East, to increase the role of universities in agricultural research and development. In addition, it is preparing a conceptual framework and guidelines for assessment and transfer of technologies for sustainable agricultural and rural development, intended for use by technology transferrers, developers, and farmers at the grass-roots level. Concerning the transfer and development of environmentally sound technologies, FAO has formulated projects for financing by the Common Fund for Commodities that involve the development of such technologies in specific processes, e.g., palm oil extraction. Activities promoting the use of natural fibres, jute and hard fibres as environmentally-friendly products are also supported.

(b) International Fund for Agricultural Development (IFAD)

35. IFAD supports research and development initiatives undertaken by other institutions, and has had substantial influence on efforts to address investment-related technology issues particularly through its grant financing for research undertaken by the international research community to generate technologies relevant to its target groups, and its support of investment projects for testing, adapting, and disseminating agricultural technologies in developing regions.

(c) International Labour Organization (ILO)

36. The activities of the ILO15/ concerning the employment implications of investment flows, new technologies and competitiveness relate to micro-electronics and information technologies as well as biotechnology and flexible specialization and global distribution of jobs. Results suggest that micro-electronics could play a key role in overcoming the North-South technological gap as the use of this technology is spreading with unprecedented speed to developing countries. A review of current and pipeline biotechnologies reveals both positive and negative socioeconomic features, i.e., small firms could benefit and rural employment be enhanced through multiple cropping and reduced costs of production, but the substitution of certain commodities exported by developing countries could create unemployment there. The shifts in the global distribution of employment resulting from the introduction of new technologies are currently being examined and appropriate investment and socio-economic policies elaborated.

37. Within ILO's perspective, technological capacity-building consists of three key elements: nurturing of individual skills, the assembling of individuals possessing those skills into effective groups, and the infusing of such skills with zeal and purpose. An ILO study of the secondary sector has revealed the role of non-governmental institutions to be no less important than that of governmental institutions and macroeconomic policy in the accumulation of technological capacity. With respect to transfer and development of environmentally sound technologies and employment, ILO's work demonstrates that some environmental conservation and management activities could be employment generating, and that in the course of economic development environmental degradation first increases and then begins to fall. ILO studies also suggest trade-offs and complementarities among environment, employment

and technological change. Ongoing and future work in this area will focus on the technology, poverty and environment interrelationship, assessment of the employment implications of environmental policies and programmes, and the operational interpretation of Agenda 21 concepts such as environmentally sound technologies and sustainable livelihoods.

(d) United Nations Educational, Scientific and Cultural Organization (UNESCO)

38. UNESCO's role is to strengthen all forms of educational activities, inter alia, by providing opportunities for retraining. Most of its activities relate to technological capability-building. With respect to programmes to stimulate technology transfer between higher technical institutions and local industries, the University/Industry Partnership in Africa (UNIPAR) assists countries, among other things, in adapting engineering education and training structures for effective technology transfer and industrialization. It will also contribute to encouraging universities and industries in developed countries to assist in the transfer and adaptation of environmentally-sound technologies to African countries. The International Fund for the Technological Development of Africa (ITFDA) is being set up to support the UNIPAR project. Under the University/Industry/Science partnership (UNISPAR) four major programmes are being developed (e.g., the Bolívar Programme and the Common Market of Knowledge (MECCO) in Latin America). UNESCO's Steering Committee on Human Resources Development for Technical Industry Stimulation aims at meeting the requirements of industry, and at identifying, designing and funding projects in which UNESCO can make a decisive contribution.

(e) United Nations Industrial Development Organization (UNIDO)

39. UNIDO activities foster investment and technology flows from industrialized to developing countries through a range of promotion and technical cooperation services of a sectoral and trans-sectoral nature. UNIDO's framework for investment-related technology transfer encompasses technology transfer through the mobilization of foreign investment resources, including financing for developing countries, the Industrial and Technological Information Bank (INTIB) and the twice-yearly technology markets (TECHMARTS) in different countries. Developing countries' technology acquisition and negotiation capabilities are enhanced through activities addressing governments, R&D institutions, enterprises and individuals. An information network on technology market and issues of technology transfer, adaptation, development and use links technology transfer agencies. This also promotes policies for technology transfer and cooperation. Advice is offered to governments and entrepreneurs through a Technology Advisory Service, and transfer of technology to small-and medium-scale enterprises is promoted through plant-level cooperation between enterprises in developed and developing countries and among developing countries. UNIDO is aimed at sensitizing policy makers to the impacts of new and emerging technologies, and stimulating the formulation of policies relative to advanced technology whose developments are reported in specialized newsletters and a Technology Trends series. UNIDO also promotes international and national centres of excellence and cooperation networks for advanced technologies, e.g., the Latin American Biotechnology Network, and arranges cooperation between R&D institutions in developed and developing countries to enhance the latter's knowledge and capacity to benefit from them. At the request of the ACC Task Force on Science and Technology, UNIDO is preparing a report on commercialization of biotechnology and intellectual property rights.

40. Through the promotion of international centres such as the International Centre for Genetic Engineering and Biotechnology and the International Centre for Science, it also contributes to the development and promotion of technologies of critical importance for developing countries. Other examples of UNIDO's technology transfer and cooperation activities are the International Rubber Research and Development Board and the Regional Network for Pesticides for Asia and the Pacific. The impact of TNCs on research is the subject of a number of studies and guidelines, and a technology transfer guide for research institutes to enhance commercialization of their work is under preparation.

41. UNIDO supports actions by countries to enhance their capacity through technical cooperation, particularly with respect to pilot plant projects. In the field of financial resource mobilization for technology transfer, UNIDO's Investment Promotion Service organizes fora for promoting investment projects, country presentation tours and an integrated software package for information on projects, sponsors and foreign partners. A new programme promotes build-operate-transfer (BOT) financing, and identifies alternative funding for investment and technology transfer.

42. Transfer and development of technologies of critical importance is the main focus of UNIDO technical cooperation services, which are organized in a sub-sectorial way to cover agro-based industries, chemicals, engineering industries and the metallurgical sector. These are closely linked with sub-programmes for industrial strategies and policies, institutional infrastructure, industrial management and rehabilitation, and industrial human resource development. UNIDO focuses on generic technologies as being of critical importance: information processing, telecommunications, new materials, new energy technologies, marine industrial technologies, genetic engineering and biotechnology. With respect to human resources development, UNIDO aims at building up capabilities in technology acquisition and negotiation, investment promotion (through "hands-on" experience for delegates to UNIDO investment promotion offices), and technology management.

43. Concerning the transfer and development of environmentally-sound technologies, UNIDO's technical cooperation addresses global environment issues covered under the Montreal Protocol, the transfer of end-of-pipe and of inherently clean, low-waste and low-energy technologies and the recycling of waste. Its advisory services assist in the relocation of polluting industries, reduction of hazardous wastes from pesticides and war, and the introduction of environmentally-sound industrial development strategies. An Environment and Energy Information System seeks to establish cost-effective mechanisms to manage environmental information required by small-and-medium scale industries. Focusing on long-term sustainable technological development, UNIDO proposes to complement a global programme with studies and technical cooperation to identify areas where the unique problems of the developing countries require changes in technological trajectories, and to take steps toward such changes.

(f) World Bank (WB)

44. The World Bank assists countries in technological capability-building through sector work and policy dialogue, sectoral projects, technical assistance and research. Its analyses of country problems and alternative ways of addressing them, taking into account technological considerations and capabilities, form the basis for specific projects that reflect the Bank's active role in technological capability-building. At the general level, this is embodied in the choice of technologies for the projects, the promotion of technology appropriate to the environment and the mobilization of local technological capacity. Concerning specific technology components, in agriculture for example, the Bank has financed research on seed varieties, irrigation and animal husbandry techniques. It has also financed research in industry, infrastructure and energy. The Bank has supported the development of sophisticated scientific and technological skills by funding technical institutes, universities and special programmes. It has also supported projects, primarily focusing on technology-related infrastructure, e.g., by financing technology dissemination and research institutions. In the industrial sector, it has created specialized institutions for financing technological development in Hungary, Israel, Republic of Korea, Mexico and Spain, and set up an electronics research facility in Korea, as well as a facility for standards and quality control in Turkey. It has also supported scientific education and research to assist the development of technical manpower in Brazil, China, Mexico and the Philippines.

45. World Bank's technical assistance and lending operations include feasibility studies, engineering design and construction, the supervision of projects, research and development, institution building, and training activities. The Bank is active in economic research and technology-related

issues such as technological capability acquisition, technology policy, foreign direct investment, intellectual property aspects, the impact of high technology on traditional industry, including computer industry policy and biotechnology potential for developing countries. It is also active in the development of technologies, for example through support to the Consultative Group on International Agricultural Research (CGIAR), and the WHO research programmes on tropical diseases and human reproduction. Concerning environmentally sound technologies, the Bank's activities include financing of pollution abatement projects as well as the transfer and development of environmentally sound technologies through industrial efficiency, and of alternative energy technology and efficient energy conservation techniques. In collaboration with UNDP and UNEP, it is implementing the Global Environment Facility which finances environment-related investments and technology development, generating global environmental benefits not otherwise possible under normal country lending operations.

(g) World Health Organization (WHO)

46. WHO activities concentrate mainly on endogenous technological capability-building. WHO considers technical cooperation among developing countries (TCDC) as one of the most appropriate tools for creating, adapting, and transferring knowledge and experience towards Health for All goals,16/ and, in recent years, it has supported the implementation of numerous TCDC projects. WHO has also supported joint international R&D projects, for example, on the rational use of drugs, malaria and schistosomiasis control techniques, simple, low-cost methods for testing water, food and air quality, and appropriate technology for water supply and sanitation. Other main activities, including support for technology-related projects, concern maternal and child health and family planning, control techniques for African trypanosomiasis and the Latin American Chagas disease, and monitoring and prevention of cardiovascular diseases. WHO is particularly aware of the impact of the environment on health conditions; it has launched special environmental health programmes concerning the management of natural resources for improving such conditions.

B. Intergovernmental organizations

(a) African Development Bank (ADB)

47. Concerning investment, science and technology-related issues, the African Development Bank's involvement is implicit in its lending operations through the various funding mechanisms it uses, in the form of grants and loans. The Bank lends to all sectors, public or private, notably agriculture, transport, public utilities, industry, health and education. The Bank's involvement in technology is articulated in its policy on Science and Technology for Development. All projects involve in various degrees the application and utilization of technology. Consequently, in the Bank's project preparation and appraisal, technology issues are reviewed to ensure that the technology adopted responds to the following basic criteria: (i) it is technically viable (and environmentally acceptable); (ii) it has proved its worth in field testing on a practical scale; (iii) it is backed by adequate after-sales servicing.

(b) Asian Development Bank (AsDB)

48. A number of AsDB's activities concern investment-related technology issues. In the field of investment flows and transfer of technology, the Bank approved in December 1991 a US$300,000 technical assistance grant for a regional study on technology transfer and development in its developing member countries (DMCs), aimed at promoting technology transfer and growth in four countries of the Asia-Pacific region - Bangladesh, China, Pakistan and the Philippines. Before finalization of the study, a regional seminar for consultants and policy makers will be held at the Asian Institute of Technology in 1993 to discuss a regional perspective for future assistance and reorientation of the Bank's approach so as to reflect the changing needs and priorities of its DMCs. Concerning technological capability-building, the Bank is currently financing a large project on Malaysia's industrial technology

development and management with emphasis on strengthening R&D capacity in the fields of automated manufacturing technology and advanced materials, on human resource development, and on enhancement of a science and technology information system. An industrial sector programme loan to Nepal aims to create a policy environment that will increase the sector's efficiency while realizing its growth potential on a sustainable basis.

(c) Association of South-East Asian Nations (ASEAN)

49. ASEAN covers various activities in relation to investment-related technology matters, stressing human resource development. Concerning investment flows, transfer of technology and competitiveness, a special joint programme by ASEAN and the United States includes a series of projects, the first of which is a six-year private investment and trade opportunities project to promote private-sector trade, investment and technology transfer among companies in the ASEAN region and the United States. It has an important technology services component aimed at promoting technology transfer, quality assurance and certification, standards development, and the development of new packaging and materials. It is also to serve as a clearing house. With respect to technological capability-building, in the 1980s ASEAN participated in the creation of specific technology centres dealing with forest management in cooperation with Canadian institutions, as well as timber production, industrialization, agricultural research and training. Concerning the transfer and development of environmentally sound technologies, ASEAN assists member countries in elaborating sustainable development strategies by promoting private-sector initiatives and strengthening local capabilities to address urban and industrial pollution, the issues of non-conventional energy research, sustainable exploitation of marine resources and solar energy. Within the context of ASEAN-US cooperation, environmentally sound technologies are central and include the development of assessment guidelines and technologies for ASEAN countries.

(d) Caribbean Development Bank (CDB)

50. The CDB contributes to the transfer of technology and to technological capability-building in its member countries, addressing in particular small and medium-sized enterprises through the Caribbean Technological Consultancy Services (CTCS) Network, which, since 1985, has been providing technical assistance in a practical form and through relevant documentation.17/ The Bank places emphasis on the environmental impact of its projects, as well as on human resource development, and will be making an in-depth study of these matters.

(e) Centre for the Development of Industry (CDI)

51. The CDI was created by the EC and ACP countries to foster small and medium-sized industrial enterprises in developing countries that were signatories of the Lomé Convention. Concerning investment and technology, and technological capability-building, CDI promotes partnerships between EC and ACP enterprises through joint ventures, and business partnerships through know-how, marketing, and management agreements. It also assists in marketing ACP manufactured products in the EC, and offers other services, including the facilitation of contacts between ACP entrepreneurs and European suppliers of technology, know-how and finance. CDI's assistance includes the selection of suitable plant and equipment, evaluation of technology, and training and technical assistance for start-up. Twenty-two investment projects involving technology transfer are concentrated in the agro-allied industries, building and construction, chemical and pharmaceutical industries, and mechanical engineering and metal industries.

(f) Commission of the European Communities (EC)

52. On the basis of a common strategy on technology, the European Community is active in various investment-related technology matters.18/ Successive Framework Programmes for Research and Technological Development have defined relevant aspects concerning research and technology policy, priorities and budget for research support for five-year periods. The EC's cooperation with

developing countries and countries in transition is financed separately and, with few exceptions, embraces programmes and projects outside the Framework. With respect to technological cooperation among member states in investment-related areas, the aim of the Framework Programmes is to strengthen the international competitiveness of European industry in high-technology sectors.19/ Technological capability-building activities figure importantly in the work of the EC, and many of them are supported by education and training programmes outside the Framework. The area of environment and of environmentally sound technologies, e.g., environmental protection and research, is assuming an increasingly prominent position in funding as compared to the 1980s.

53. Concerning cooperation with developing countries and countries in transition, the main EC programmes of cooperation in technology and investment are the activities of the Centre for the Development of Industry (CDI), the Science and Technology for Development Programme (STD), the International Scientific Cooperation Programme (ISC), and the European Community Investment Partners Scheme (ECIP), of which only the STD is financed under the Framework Programme. The following activities are being carried out or are in the planning stage: (i) with respect to technology transfer and competitiveness, the ECIP constitutes a financial instrument for investment promotion, facilitates in particular the licensing and joint ventures between local operators in Asia, Latin America, Mediterranean countries (ALA/MED) and their European counterparts, and serves as a vehicle for technology transfer. Within the framework of the Lomé Convention, the promotion of investment and cooperation between enterprises, which, inter alia, aims at technology transfer, includes three elements: the activities of the Centre for the Development of Industry (CDI), activities in the area of investment protection and guarantees, and the organization of regional industrial and sectoral conferences; (ii) concerning technological capacity-building, the Science and Technology for Development Programme (STD) operates partnerships between researchers and institutions in EC and ACP countries, and offers advanced training and cooperation in institutional development in the fields of health and agriculture. The International Scientific Cooperation Programme (ISC) encompasses joint research between centres in the EC and those in ALA/MED countries. The EUREKA project promotes cross-border cooperation in European research and technology, and is to complement Community research. LET'S GO EAST, still in the planning stage, is conceived as a short-term emergency programme for Eastern European countries. The programme is to support joint research projects to encourage transfer of technologies and know-how to Eastern Europe; to help evaluate R&D needs; to provide scientific and technical equipment, as well as fellowships for researchers and experts; to support joint scientific congresses and seminars; and to prepare future aid and cooperation programmes, such as EAST (European Assistance in Science and Technology); (iii) cooperation on environmental issues is increasing in importance.

(g) Consultative Group on International Agricultural Research (CGIAR)

54. CGIAR serves as a bridge between strategic research institutions in advanced countries and national research institutions in developing countries, with the aim of strengthening technological capability-building in agriculture-related areas. CGIAR work includes an important concern for environmentally sound technologies.20/ Its work is considered of particular importance for the sustainable conservation and use of plant genetic resources. CGIAR has adopted an "ecoregional" approach in order to focus and coordinate its research skills for sustainable production and conservation of natural resources. It currently works in partnership with research groups in various countries and regions, and at the international level. It is also developing a research model embracing the physical, biological and human dimensions of long-term sustainable agricultural production. Five CGIAR international research centres are working with the Food and Agriculture Organization (FAO) to provide detailed information on new technologies in order to assist countries in formulating policies for the choice and application of such technologies.

(h) European Investment Bank (EIB)21/

55. The EIB - the financial institution of the EC - finances projects all of which include technology elements whose nature is determined by countries' comparative advantages, industrial competitiveness, labour productivity, and environmental factors. With the establishment of the European Single Market in 1993, great importance has been attached to the financing of measures to help strengthen the international competitiveness of European enterprises, encouraging business competitiveness, research, and technology development. With respect to environmentally sound technologies EIB projects have included the areas of water, air, waste, and urban development. Concerning bank financing outside the EC in relation to technologies linked to these areas, EIB has cooperated with the EC Commission, the World Bank, UNDP, EBRD, and the Nordic Investment Bank in financing projects for environmental protection and sustainable development, e.g., the Mediterranean Environmental Technical Assistance Programme (METAP). In addition, an environmental rehabilitation initiative is planned for countries bordering the Baltic Sea, the Elbe and the Danube.

(i) Inter-American Development Bank (IDB)

56. Concerning investment-related technology matters, the IDB is providing technical cooperation funding and support to the Bolívar Programme, and has set up the Latin American Agency for Science and Business (ENLACE), now fully operational, for this purpose. The objectives are to promote linkages and technology transfer among enterprises in different countries of the region and between these and research and development institutions. It is also intended to stimulate the mobilization of financial resources, including those of bank operations, through the generation of technological development projects to be carried out by enterprises in the region with the possible participation of enterprises and/or research centres from other regions.22/

(j) International Centre for Public Enterprises in Developing Countries (ICPE)

57. ICPE is focusing its activities on investment-related technology policy and management. In the field of investment flows, transfer of technology and competitiveness, ICPE activities aim at development of "late-comer" strategies based on the proper balancing of foreign and domestic technological inputs, using the investment context as the dynamizing factor for optimal interaction. Concerning technology capability-building, ICPE's main ongoing projects are the management of technology in the framework of public enterprise adjustment and restructuring programmes in developing countries, inter-enterprise strategic partnership/alliances as a vehicle for transfer of technology and technological cooperation, and the management of foreign investment/collaboration arrangements as part of public enterprise restructuring/privatization programmes. ICPE believes that the sequence of building up local technological capabilities in developing countries should basically be along "reverse engineering" lines, and should develop the technology policy and management capabilities of the main implementers of the technological innovation process in developing countries. ICPE is strengthening cooperation among developing countries' consultancy and engineering organizations (CEDOs) to improve their access to the international consultancy/engineering services market.

(k) Islamic Development Bank (IsDB)

58. IsDB intervenes in different ways, in accordance with its commitment, to strengthen competitiveness and to support the building of national technological capabilities in its member countries. These operations include loan financing, equity participation, leasing, technical assistance and trade financing. IsDB endeavours to ensure that the relevant technology and know-how training is provided along with plant and equipment to beneficiary companies in its member countries, and that their personnel participate in the process of plant design, installation and operation. Other activities of IsDB include the financing of feasibility studies, detailed engineering design, supervision of project implementation, and training of personnel during project

preparation and implementation. The IsDB technical cooperation programme aims, inter alia, at enhancing the efficiency of projects financed by the Bank. IsDB also provides support to member countries in assimilating acquired technology, on-the-job training and the organization of seminars and workshops, as well as scholarship programmes for students to pursue their studies in scientific fields. Its Islamic Research and Training Institute is developing an Information System Network to provide direct support for scientific research, technological applications, and exchange of information. With respect to the transfer and development of environmentally sound technologies, IsDB recognizes the need to incorporate environmental factors in its financing, and has emphasized environmental conservation in its strategic planning. It finances pilot projects, such as biosaline agriculture, solid-waste management, biotechnology, date-palm research, a development network for the Near East and North Africa, and the promotion of environmental awareness and cooperation.

(l) Latin American Economic System (SELA)

59. The subject of technological development and industrialization has been defined in SELA's 1993-1994 Work Programme as one of the organization's priority areas. SELA carries out various activities related mostly to aspects of technology transfer and competitiveness. It performs sub-regional and regional coordination functions in the overall area of science and technology: for example, it organized a meeting of SELA organizations such as the Latin American Commission on Science and Technology (COLCYT), the Latin American Network of Technology Information (RITLA) and the Bolivar Programme on Regional Technological Integration, Innovation and Industrial Competitiveness. It is planning a coordination meeting in parallel with the XIX Ordinary Meeting of the Latin America Council in October 1993. SELA also carries out coordinating functions in the area of technological innovation, and is undertaking a biotechnology project with the EC, while continuing studies to promote new technologies at the regional level. The organization is planning the IV Regional Forum on Intellectual Property to promote the harmonization of positions on the subject. In this context, the secretariat is elaborating a technical cooperation programme among developing countries, based on a TCDC approach. In early 1994, SELA will hold the First Regional Forum on Industrial Policy to promote a dialogue on industrial and technology aspects of the transformation occurring in the region's productive sector.

(m) Organization for Economic Cooperation and Development (OECD)

60. Concerning investment flows, transfer of technology and competitiveness, the Directorate for Science, Technology and Industry carried out work on the impact of new technologies on investment and competitiveness, which was reflected in the 1992 OECD Science and Technology Outlook. These issues are further examined in the context of the preparation of the 1994 issue of the Outlook. In relation to the globalization of industrial activities, a study on the impact of foreign investment on domestic economies of OECD countries will be available in 1993 for discussion by the Industry Committee. The Directorate also prepared papers on the impact of national technology programmes and on generic technologies. Concerning policies for technology transfer among firms, institutes and universities, as well as technology transfer evaluation, studies were carried out on the former Czechoslovakia, Hungary, Iceland, Mexico, Portugal and Russia. In the case of Mexico, particular attention is being paid to human-resource aspects of technological development and transfer, as well as to the role of financial systems in technology-related investment with a view to improving competitiveness.

61. The Technology and Environment Programme, managed by the Environment Directorate, examined a number of cases in "clean technologies" trade. The evidence obtained led to the conclusion that trade-related policies and practices, including intellectual property rights, are not significant obstacles to trade in clean technology. Other obstacles were seen to be more important and also have an effect on the generation, transfer and diffusion of environmentally sound technologies. One such obstacle relates to a lack of appropriate environmental regulations in a number of countries. In the cases where clean technologies offered no cost advantage over existing or

traditional production technologies, industries had no incentive to import them if not forced to do so by new environmental standards. Another major obstacle is the lack of access to financing. Although stronger environmental regulations required firms to obtain cleaner technologies, they were unable to import them owing to insufficient funds or credit, even when the cleaner technologies offered lower operating costs and were economical in the long term. This problem was most acute in the high-debt countries of Latin America and Central and Eastern Europe. Therefore, the finding suggests that strengthening environmental standards alone in non-OECD countries will not be sufficient to encourage an expansion of trade in clean technologies. Focusing exclusively on trade policies in discussions of the transfer of environmentally sound technology may simply divert attention from what are considered by the participants in clean technology trade to be the real problems, thereby delaying development of effective solutions to these problems.

62. Concerning technology evaluation, the programme prepared a "Government Self-Assessment Guide" to promote development and implementation of clean technologies. Three OECD countries are currently pilot-testing this Guide, and a report will be issued in 1993. Concerning policies and measures to promote environmentally sound technologies, OECD has analyzed the relationship among industrial policy, pollution prevention approaches and environmental management in industry, and has worked out policy options.23/ In cooperation with UNEP (IE/PAC), a workshop was held in 1993 to involve developing countries in cleaner technology policy development. OECD also examined government financial support programmes (currently running at US$1.5 to US$2 billion per year) aimed at increasing the development of cleaner technologies. A workshop on this subject was held in 1993, and a report of the results will be issued later in the year.

(n) Preferential Trade Area for Eastern and Southern African States (PTA)

63. PTA is active in priority sector initiatives concerning investment-related technology issues in its member countries. With regard to technological capability-building, the PTA is currently establishing a Metallurgical Technology Centre (MTC) in Zimbabwe aimed at developing technologies for the utilization of local and imported raw materials in the metallurgical and allied industries. The Centre will also train personnel and provide consultancy services for the metallurgical industries. Institutions established in member States carrying out similar activities will be networked and coordinated by MTC. Another initiative, the Leather and Leather Products Institute established in Ethiopia, is carrying out R&D activities, consultancy services and training to improve the quality of hides and skins produced in the subregion. The Institute is also playing a leading role in the adaptation and development of technology. Another project of importance to agriculture aims at upgrading the techno-economic viability of seed dressing technology specifically tailored to the needs of the African small-scale rural farmers with a view to promoting its widespread utilization within the PTA region. Of importance to small and medium-scale enterprises in the PTA area is the organization of a technology market forum (TECHMART), to be held in August 1994 in Lusaka in cooperation with the Government of Zambia. In the field of telecommunications, PTA, in cooperation with other organizations and ITU, is supporting a project aimed at assessing the capability of African countries to manufacture telecommunications equipment with view to developing an integrated programme for their production. A computerized database on the telecommunications industry in Africa is to be established.

64. With respect to environmentally sound technologies, PTA attaches primary importance to environmental concerns in the design and implementation of all projects, in order to preserve the subregion's ecosystem and to arrest and reverse the effects of environmental degradation and industrial pollution.

C. National organizations

(a) Finnish Fund for Industrial Cooperation (FINNFUND)24/

65. With respect to investment and technology capability-building matters, FINNFUND, an independent public development finance corporation, promotes Finnish investment in Asia, Africa, Latin America, the Middle East and Central and Eastern Europe. Its financing facilities aim at encouraging the establishment of joint ventures with Finnish investment partners through the co-financing of feasibility studies and through other investment preparations, including assisting investors in choosing an appropriate technology. In the last five years, FINNFUND's portfolio, by sector, was distributed in the following way: 38 per cent chemical industries, 23 per cent metals and machinery, 12 per cent finance and planning, 8 per cent food and agro-business, 7 per cent construction materials, 5 per cent forestry management and 7 per cent others.

(b) German Agency for Technical Cooperation (GTZ)

66. The GTZ carries out technical cooperation activities commissioned by the German Government. The Agency's tasks include the planning, implementation and monitoring of programmes and projects, the extension of advisory services to other development institutions, the selection of experts, backing of field work, training and financial monitoring. Concerning technological capability-building, the German Appropriate Technology Exchange (GATE), a division of the GTZ, is a centre for the dissemination and promotion of appropriate technologies. It operates an Information and Advisory Service on Appropriate Technology (ISAT), which evaluates the efficiency of technologies on the basis of their development contribution and environmental impact. Cooperation on environmental technologies is concentrated in the areas of water, sewage, and energy technologies, and covers training in energy management and auditing, investment project evaluation and research into the improvement of energy efficiency in industry.

(c) International Development Research Centre (IDRC)

67. Through support for research, Canada's International Development Research Centre (IDRC), assists scientists in developing countries to identify long-term, workable solutions to pressing development problems. Support is given directly to scientists working in universities, private enterprises, government and non-profit organizations. Priority is given to research aimed at achieving equitable and sustainable development worldwide. Projects are designed to maximize the use of local resources, and to strengthen human and institutional capacity. IDRC is active in the fields of environment and natural resources, health sciences, information sciences and systems and social sciences. Particular emphasis is placed on six cross cutting environment and development themes: integrating environmental, social and economic policies; technology and the environment; food systems under stress; information and communication for environment and development; health and the environment; and biodiversity. IDRC is directed by an international Board of Governors and is funded by the Government of Canada.

(d) Swedish Agency for Research Cooperation with Developing Countries (SAREC)

68. SAREC has a long experience in the field of technology capability-building: It has contributed to the building up and strengthening of science and technology capacity in over 200 university departments and research institutes in 15 developing countries. Six of these countries are in Africa, three in Asia and six in Latin America. The main tools used by SAREC in its technological capability-building activities are the Regional and International Programmes and its Bilateral Research Cooperation Programme. The content of this Programme is determined by the relative strength of the scientific and technological capacity of the participating countries. In countries with a weak science and technology set-up, the main thrust is to strengthen the national research capacity, while in more developed countries the main objective is to generate research results of importance to the

country concerned, as well as to other developing countries. SAREC concentrates its research cooperation activities in scientific and technological areas where Sweden has advanced expertise to offer.25/

D. Non-governmental organizations

(a) International Association of Trading Organizations for a Developing World (ASTRO)

69. ASTRO was initially established as a cooperative institution of State-owned trading companies but is now open for membership to trading organizations of developing and developed countries as well as countries in transition. Concerning technology transfer, investment and competitiveness, ASTRO's basic objective is the promotion and facilitation of trade cooperation and development among its member organizations. Its work includes providing support services and information on trade and technology transfer arrangements to business enterprises. Responding to the demand from developing countries for these services, ASTRO member countries established the ASTRO Facilitation Centre for Industrial Offsets, Investments and Counter-trade (ASTRACO), which aims, inter alia, at identifying potential business partners for concluding industrial development transactions, and at designing and conducting training programmes at the national, regional and interregional levels. In the field of technology capability-building, ASTRO's Institute for Trade Management provides training in trade management and operations for personnel in trading organizations.

(b) International Federation of Consulting Engineers (FIDIC)

70. The FIDIC has not undertaken any recent work in investment-related technology issues, nor does it plan such work for 1994-1995. However, it has formulated specific policies on the transfer of technology and the promotion of environmentally sound technologies. FIDIC thus recommends the transfer of appropriate technologies in projects in the developing world. It attaches great importance to environmental issues, especially sustainable development, and expects consulting engineers to evaluate in all cases the environmental impact of projects and take appropriate action to mitigate any environmental problems.

(c) International Chamber of Commerce (ICC)

71. Concerning investment flows, transfer of technology and competitiveness, the promotion of international direct investment is one of the priority issues dealt with by the ICC. The Commission on Intellectual and Industrial Property has for many years been concerned with the problem of transfer of technology vis-à-vis its intellectual property aspects. Seminars on technology transfer have been regularly organized by the ICC, the latest on "Technology for Development" in 1992, and the next to be held in 1994 on "Technology Transfer in Eastern and Central Europe: Opportunities for International Business". In cooperation with its specialized division, the ICC World Industry Council for the Environment (WICE), the Commission on Intellectual and Industrial Property will focus on the emerging problem of transfer of environmentally sound technology.

72. The ICC Commission on Multinational Enterprises and International Investment has for many years given high priority to the promotion of private foreign direct investment, notably in developing countries. Recently it set up a high-level Working Party to look into the practical factors influencing the decision-making process of foreign potential investors, including the legal, administrative, financial and social infrastructures in host countries. The Working Party Report underlined the importance of a clear, stable legal system in the host country for attracting investment. As regards intellectual property rights, the absence of laws and non-adherence to the relevant international conventions in a potential host country was perceived as a major disincentive for foreign investors. The report also noted that certain conditions created by host countries for approval of foreign investment e.g., that certain transfers of technology be made from the foreign mother company, or that a fixed percentage of local revenue be used for R&D in the host

country, could result, inter alia, in higher costs, inadequate use of resources, and slower technological progress. It also emphasized the importance of education for growth, new investment and job creation and urged that special programmes be set up in conjunction with national and multinational enterprises, for vocational guidance and the development of skills to meet the needs of business and industry. In cooperation with the United Nations Centre on Transnational Cooperations, the ICC has published a manual, "Bilateral Investment Treaties 1959-1991", for policy makers, corporate executives and researchers concerned with foreign investment.

(d) International Organization for Standardization (ISO)

73. ISO activities in the area of investment-related technology issues are of a specific technical nature and concentrate on technological capability-building aspects. ISO contributes essentially to building up or improving national standardization infrastructures in each country, which are considered to be a central element in increasing countries' capacity to adapt, upgrade and create technology. This infrastructure should be closely linked to the corresponding activities at the international level to ensure that it follows current developments in other countries, thus helping to make an individual country's products compatible with the requirements of global markets.

74. The national standardization infrastructure consists of: (i) standards information services; (ii) testing facilities to assess the compatibility of new technologies and products with relevant technical regulations in force; (iii) certification infrastructures which facilitate access to export markets for products marketed by developing country industries; and (iv) quality improvement structures, such as internationally recognized standards for quality management systems (e.g., ISO 9000 series of standards) and quality training.

(e) Latin American Association of Development Financing Institutions (ALIDE)

75. ALIDE is active in the area of promotion of investment and business ventures. Its secretariat coordinates a Network of Projects and Investments through national focal points in Latin American and Caribbean countries, and has also set up a Service on Financial and Technological Information concerning Projects and Investments (SIFT). Its main objective is to provide specialized and systematized information to development, international and commercial banks, and to entrepreneurs, investors and promoters of investment projects in the Latin American and Caribbean region. The information provided is updated regularly and relates to statistics, technologies and investment opportunities.

(f) Technological Information Promotion System (TIPS)

76. The Technological Information Promotion System was founded in 1984 by the United Nations Development Programme (UNDP) within the framework of South-South cooperation implemented by DEVNET, which is becoming an international non-governmental organization. It provides for a daily exchange of information on scientific, technological and business opportunities among developing countries. In the fields of technology transfer and technology capability-building, TIPS has established itself as a functional technological and trade information network covering 14 sectors of activity, such as agro-industry, biotechnology, chemicals, mining, energy and packaging. It now possesses a very comprehensive database on supply and demand in the countries of the South, and it continues to expand rapidly. National bureaux have been created in various Central and South American countries as well as in the Middle East, Asia and Africa. The Spanish Editing desk has been established in Caracas (Venezuela) and the English desk is operating in Manila (Philippines). The general objectives of TIPS for the near future are the institutional, operational and economic consolidation of the system, and its geographical expansion.

(g) World Assembly of Small and Medium Enterprises (WASME)

77. WASME, with members and associates in 75 industrialized and developing countries, is a non-governmental organization actively engaged in the creation of an environment allowing a more dynamic growth of small and medium sized enterprises, particularly in developing countries. WASME acts as a clearing-house for information relating to these enterprises with respect to legislation, policies, projects, programmes and various schemes, in particular through its monthly "Newsletter". Activities specifically involving investment-related technology issues include the promotion of enterprise-to-enterprise cooperation in technology transfer and skill development, the updating of a roster of experts/consultants, the establishment of a Technology Promotion and Exchange Centre at WASME headquarters, and the organization or sponsoring of consultations, seminars, workshops and conferences.

Notes

1/ "Cartagena Commitment" (TD/364).

2/ "Report of the Ad Hoc Working Group on the Interrelationship between Investment and Technology Transfer on its first session" (TD/B/39(2)/18 TD/B/WG.5/4).

3/ Ibid, annex 1, para. 7. (b).

4/ Two of these organizations (the World Intellectual Property Organization and the Conference on Security and Cooperation in Europe) wrote to state that they were not involved in specific activities on investment-related technology issues.

5/ The DESD was created on 1 March 1992 to consolidate the functions and mandates of, inter alia, the United Nations Centre on Transnational Corporations and the Centre for Science and Technology for Development, and operated on that basis until 1993. Part of these functions are now integrated into UNCTAD.

6/ Recent publications in this domain include: "Third World transnational corporations and their impact on home developing countries" (ST/CTC/133); "The Impact of Trade-related Investment Measures on Trade and Development" (Joint publication with UNCTAD, E.91.II.A.19); "Government Policies and Foreign Direct Investment" (E.91.II.A.20); "From the Common Market to EC 1992 - Regional Economic Integration in the European Community and Transnational Corporations" (E.93.II.A.2).

7/ "Environmentally Sound Technology for Sustainable Development" (ST/STD/ATAS/7).

8/ "Report of the Secretary-General on the assessment of the effect of activities of the United Nations system related to the process of creating and strengthening endogenous capacity-building in science and technology in developing countries" E/CN.16/1993/4.

9/ E/C.7/1993/9 of 1 March 1993; and E/C.7/1993/12 of 24 February 1993.

10/ For recent documents issued in this field, see: "Le rôle des sociétés transnationales dans le développement de l'informatique en Afrique" (E/ECA/UNCTC/63); "Développement du système informatisé sur les données financières en Côte d'Ivoire" (E/ECA/UNCTC/73); "Les techniques de negotiation en matière de transfert de technologie: les contrats de licence dans les entreprises africaines" (E/ECA/UNCTC/56); "Le transfert de technologie dans les industries pétro-chimiques en Afrique du Nord: le cas de l'Algérie" (E/ECA/UNCTC/61); "Le transfert de technologie dans le secteur africain de l'alimentation: étude préliminaire" (E/ECA/UNCTC/50); "Le transfert de technologie dans les industries agro-alimentaires en Afrique Centrale: le cas de l'industrie du sucre du Congo" (E/ECA/UNCTC/55); "Transfer and development of new technologies in Africa- Case on Renewable Energies in Burundi" (E/ECA/UNCTC/83); "The Role of TNCs in the Transfer of Bio-technology in Africa: Case study of Tanzania" (E/ECA/UNCTC/87 and E/ECA/UNCTC/78).

11/ Among the most recent documents published, see: TRADE/R.588 of 9 November 1992; and TRADE/WP.5/R.9/Rev.1 of 25 November 1992.

12/ Recently ECLAC published, inter alia: in 1991: "Industrial Modernization in Mexico" (LC/L.613); "Perspectivas del comportamiento tecnológico de las empresas nacionales y transnacionales en la industria del Brasil" (LC/R.1050); "Empresas transnacionales y restructuración industrial en Colombia" (LC/R.1052); "Cooperación industrial entre países desarrollados y en desarrollo: un estudio de caso en Chile" (LC/R:1054); "El papel de las empresas transnacionales en la restructuración industrial de Colombia: una síntesis" (LC/R.1055). In 1992, it published, among others: "Capital

extranjero en el sector industrial: caso peruano" (LC/R.1053); "Análisis de la encuesta sobre empresas con inversión extranjera directa en la industria colombiana" (Documento de Sala de Conferencia, DSC/3); "Latin America's Experience with Technology Policies: Current Situation and Prospects" (prepared by the International Workshop on Systems of Innovation, organized for CNRS-LATAPSES - Bologna University); in 1993: "A New International Industrial Order" (LC/R.1268); "Transnational Corporations and the Manufacturing Sector in Brazil" (LC/R.1261); "Transnational Corporations and Industrial Modernization in Brazil" (LC/R:1260).

13/ Recent advanced UNDP pipeline projects include, for example, in Latin America, projects on boosting science and literacy in elementary and high school education; strategic science and technology key decision-making practices; transfer of technology in specific products, such as for spice and cognate native products; exploration of possible new types of technology-driven business; in Africa: technology for small mining operations, technology commercialization in the food processing sector, namely coffee processing; multi-disciplinary natural resources exploitation; cooperation among universities, e.g., in the field of telecommunications; in countries in transition to market economy: projects on plant reorganization and new options; programmes for optimal utilization of medical technology; in Asia: bio-preservation; new materials production; post-harvest organization.

14/ "The World Environment 1972-1992", published in December 1992 was a major UNEP report which outlined the major environmental trends and issues over the past 20 years. The Governing Council, which commissioned the report, believes that it is an important benchmark for action on sustainable development and, at its 17th session, agreed to provide another world environment report 10 years hence.

15/ Some recent ILO publications dealing with investment-related technology issues include the following - Books/monographs: Iftikhar Ahmed (ed.) "Biotechnology: A Hope or a Threat?", foreword by Micheal P. Lipton (London, Macmillan, 1992); Susumu Watanabe (ed.) "Microelectronics and Third World industries" (London, Macmillan, 1993); D.J.C Forsyth "Technology policy in small developing countries" (London, Macmillan, 1990); J.L Enos "The creation of technological capability in developing countries" (London, Pinter, 1991); Carlos Maldonado and S.V. Sethuraman (eds.) "Technological capability in the informal sectors of developing countries" (Geneva, ILO, 1992); A.S Bhalla (ed) "Environment, employment and Development (Geneva, ILO, 1992). ILO World Employment Programme Working Papers: Jeffrey James "New technologies, poverty and employment: The future outlook" WEP 2-22/WP.230, Geneva, ILO, May 1992; Massoud Karshenas "Environment, employment and sustainable development" WEP 2-22/WP.237, Geneva, ILO, December 1992; Theodore Panayotou "Empirical tests and policy analysis of environmental degradation at different stages of economic development" WEP 2-22/WP.238, Geneva, ILO, January 1993.

16/ Selected recent publications from the WHO include the following: "Technical Cooperation among Developing Countries in Support of Health for All: Implementation of Resolution WHA43.9: Report by the Director-General" (EB89/21); "Intensified WHO Cooperation with Countries and Peoples in Greatest Need: Report by the Director-General" (A46/INF.DOC/2).

17/ Information on the activities of the CTCS are provided in the annual reports of the "Caribbean Technological Consultancy Services Network".

18/ See: "Notes on EC Scientific and Technical Cooperation with Third World Countries"; Commission Staff Working Paper on "Transfer of Technology" for the First Substantive Session of the Commission on Sustainable Development; "Note descriptive des activités de la Communauté dans le domaine de la promotion des investissements dans les Etats ACP"; ECIP - "European Community Investment Partners" (information leaflet).

19/ The current Third Framework Programme (1990-1994) distributes a budget of ECU 5,700 million to companies in the industrial sector, universities, and private and public research institutes, largely for research on technology-related activities. Information and communications technology and industrial and materials technology are the most important areas of the Framework Programmes. These activities are backed by programmes outside the Framework, in particular SPRINT, a support programme for innovation and technology transfer, STAR and VALOREN, programmes for the development of regional infrastructures in telecommunication and energy, as well as a number of other programmes aimed at developing databases and information systems.

20/ This contribution is based on the following material made available to the Secretariat: "The Ecoregional Approach to Research in the CGIAR" Report of the TAC/Center Directors Working Group (March 1993); CGIAR 1992 Financial Report.

21/ The following contribution is based upon EIB annual reports (1990, 1991, 1992) made available to the secretariat.

22/ Within this context, the Instituto Superior de Economia e Gestâo of Portugal has recently published a document entitled "The Eureka Program and the Bolivar Program: A new model for international cooperation in technology" (Centro de Estudios y Documentacion Europea, 1992).

23/ See: "Trade Issues in the Transfer of Clean Technologies", OECD, Paris, OECD/GD(92)93 (1992); "Government Policy Options to Encourage Cleaner Production and Products in the 1990s" OECD/GD(92)127 (1992).

24/ This contribution is based on FINNFUND's Annual Report 1992, made available to the secretariat.

25/ See: SAREC annual reports 1990/91, 1991/92; "The SAREC model: Institutional cooperation and the strengthening of national research capacity in developing countries" (M. R. Bhagavan).

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FOSTERING TECHNOLOGICAL DYNAMISM: EVOLUTION OF THOUGHT ON TECHNOLOGY CAPACITY BUILDING AND COMPETITIVENESS

Summary of the review and analysis of the literature

Report by the UNCTAD secretariat

GE.93-53533 (E)

CONTENTS

Chapter		Paragraphs	Page
	Preface	1 - 3	3
	Introduction	4	3
I.	**Evolving attitudes regarding technology, capacity-building and competitiveness**	5 - 14	4
II.	**Technological capacity-building**	15 - 40	8
	A. Technological capacity-building (TCB) in developing countries by enterprises	15 - 25	8
	B. National measures for technology capacity-building in developing countries	26 - 40	10
III.	**Technology, competitiveness, industrial policies**	41 - 70	14
	A. Enterprise-level strategies for attaining and maintaining international competitiveness	41 - 47	14
	B. Strategic intervention: technology, competitiveness and industrial policy	48 - 59	15
	C. Strategic intervention: the debates over infant-industry protection and industrial policy	60 - 70	18
IV.	**Technological strategies for the least developed countries (LDCs)**	71 - 85	21
V.	**Technology for agricultural development in developing countries**	86 - 96	25
VI.	**An agenda for further research**	97 - 108	29

Preface

1. In accordance with the work programme of the Ad Hoc Working Group on the Interrelationship between Investment and Technology Transfer adopted at its first session (25-29 January 1993) and endorsed by the Trade and Development Board at its second executive session, the UNCTAD secretariat has undertaken a comprehensive analytical review of the literature on technological capacity-building and on the role of technology in the international competitiveness of nations and their enterprises.

2. A preliminary version of the review has been prepared largely by Professor Dilmus James, University of Texas, while he was working at UNCTAD. It has also benefited from inputs by Dr. Norman Clark, University of Sussex, Dr. John Enos, Oxford University, Mr. Andrew Hall, University of Sussex and Dr. Martin Fransman, Institute for Japanese-European Studies, who have also provided comments. The review is now being revised and will be published as a United Nations sales publication in the coming months.

3. The present report constitutes an extensive summary of the above-mentioned review. The literature that has been examined in preparing the review and the present report has been reproduced as background document UNCTAD/ITD/TEC/12.

Introduction

4. Technology and technological change affects productivity, amount and composition of output, levels of employment, skill profiles of the workforce, degree of competitiveness and trade flows. In the longer term, technology has a bearing on cultural values, social relationships and configurations of political power. It is, then, little wonder that the process and effects of technological advance continue to attract increasing attention among scholars, decision makers and practitioners in the laboratory or at the point of application. The analytical review undertaken by the secretariat deals with two subsets of these concerns: (i) how can countries, in particular developing countries, acquire and gain mastery over technology, including the organization of production processes, that is relatively new to them? and (ii) how do technology transfer and the accumulation of technological capacity affect competitiveness at the enterprise and national levels? The literature discussing these issues is vast. In this study, an attempt is made to focus on selected literature that has a direct bearing on the question of technological capacity-building and competitiveness. Although the agricultural sector is by no means ignored, technological capacity-building is analysed mainly in reference to the industrial sector. A special section is also devoted to the particular concerns of the least developed countries.

Chapter I

Evolving attitudes regarding technology, capacity-building and competitiveness

The neoclassical position

5. Until quite recently, orthodox neoclassical economists have tended to take technological progress for granted. In their microeconomic analysis, the production function, depicting all combinations of inputs for producing a given amount of output, is taken to be the centre of the firm's technological knowledge. Inventions and discoveries are generally considered as exogenous factors which create a pool or shelf of readily available technology in the public domain from which firms can choose. Thus, in neo-classical analysis, typically the acquisition of knowledge is assumed to be costless or at most incurring only a modest one-off expense. The element of time is ordinarily de-emphasized by presupposing instantaneous acquisition of technology. When the analysis occasionally focuses on generating technology de novo, the analogy with an ordinary investment decision is very close; that is, the firm compares the cost with prospective returns, both properly discounted, and weighs the probabilities of success or failure. Very often the analysis assumes perfect competition, which means, among other things, that the entrepreneur is omniscient about the market for inputs including technology. Relative product and factor prices constitute the core-data dominating decisions by the firm.

6. Since the late 1950s, mainstream economics has gradually come to recognize the important role of technological change in the process of economic growth. However, until very recently, the economic analysis of the origin, pace and direction of technological change has been largely ignored, or examined only within a highly reductionist and abstract framework. During this period, the focus of study centred on the ex post consequences of introducing new technology and to a great extent this remains so today.

The "developmentalist" position

7. Of the different schools of economists that have diverged from the neo-classical position, the "institutionalist economists" have always considered technology as a core element in economic development, but they have not been influential in forcing the technology debate into the field of development economics. Similarly, the impact in this respect of both the "structuralist" and the "dependency" schools has been minimal despite frequent references to the importance and desirability of technological progress in their writings. However, during the late 1960s and early 1970s, some development economists, referred to as "developmentalists" for the purposes of this study, began to sense that the very levels of abstraction and restrictiveness of the assumptions that had lent elegance and broad applicability to orthodox economics were limiting its usefulness in understanding the process of technological change. They began treating technology transfer and technological innovation within a political economy context and as an endogenous analytical variable and, therefore, a major element in determining economic growth and socioeconomic development. This was also a period when

many large developing countries established regulations governing technology imports and the national science and technology councils. It is obvious that there was some dissatisfaction concerning the manner in which technology was being analysed and the existing institutional mechanisms used for acquiring technology. Thus, the period from 1965 to 1975 can serve as a benchmark for identifying major differences in past and present treatment of technological change relating directly or indirectly to technological capacity-building and competitiveness.

8. In the past, there was heavy emphasis on transfer of technology rather than its internal generation in developing countries. Although developmentalists saw some room for expanding domestic innovational activities in developing countries, the brunt of the discussion on this issue revolved around acquiring technology from abroad and gave little recognition to endogenous technological capability.

9. At this stage, most writings on technology tended to focus on the technology transfer process and, in particular, the imperfections in the existing channels for transferring technology. There was also a widespread belief that technologies developed in mature industrial countries were ill-matched to the conditions, i.e., factor endowments, market sizes, and basic needs of the masses, in developing countries. This outlook meant that more weight was given to the choice of suitable production techniques. In this respect, transnational companies were viewed as the main channels for transferring technology under market conditions. However, the role and effectiveness of these enterprises in transferring technology was widely criticized. It was alleged, for example, that they provided technologies which were unsuitable for developing country conditions and, moreover, they charged higher prices even when the marginal cost to them for supplying already existing technology was zero or very close to it. Another complaint levelled at transnational enterprises was that technology was often transferred as part of a package or bundle tying technology to finance, managerial know-how, marketing capabilities and frequently with contractual provisions not advantageous to the purchaser. Thus, in part because of these experiences, the literature has tended to concentrate on monopolistic elements in the market and the cost to technology buyers. This, in turn, has had a major influence on some policy makers as reflected by the establishment, in a number of developing countries, of regulations governing technology imports. It should be noted, however, that the thrust of the literature and policy prescriptions has been directed at "defensive" measures to remedy defects in the international market for technology rather than positive actions designed to foster indigenous technological capability. Furthermore, during this period very little attention was focused on the technical learning process at the firm level.

Intervening events and the current "developmentalist" position

10. Several events and trends contributed to the evolution of the developmentalist position. These include, first, the rise of the East Asian super-exporters which aroused interest in learning about the origins and determinants of technological change in developing countries; second, a growing number of studies on innovational activities in mature developed countries which greatly advanced the understanding of how technological change

comes about; third, the recognition that many firms in developing countries did innovate, a few of them being able to undergo major technological transformations; fourth, the curiosity about the non-convergence of country growth rates led to a fresh interest in the detailed mechanics of technical learning and the process of technological capacity-building; fifth, the liberalization of much of the world economy has placed technology in the spotlight as countries exhibit a growing preoccupation with achieving and maintaining international levels of competitiveness; and finally, over the past three decades technology has become much more prominent in various economic theories, including international trade theory, the product-cycle theory, and more recently, the technology-gap literature in which technological change is considered an endogenous factor in the analysis.

11. Due partly to the above factors, over the past several decades attitudes towards technology and technological change have changed significantly. First of all, with the emergence of alternative sources of technology transfer, the former preoccupation with monopolistic imperfections in the international technology market and the associated call for regulations on technology imported by developing countries has waned. Second, while obtaining technology from abroad remains important to most developing countries, technology transfer is now seen primarily as a means of accumulating internal technological capacity rather than an end in itself. In addition, the problem of choosing the most appropriate technology has been far less conspicuous in recent literature with the emphasis shifting from the choice of technology to what a firm does with it after securing it. What is more, the recognition that incremental innovations at the firm level can increase the productivity of installed capacity and the fact that productivity levels can vary widely even among firms in the same industry using similar technology has contributed to a decline of interest on the initial choice of technology. Regarding actual and latent innovational abilities in developing countries, the new consensus is that domestic innovation, R & D activities and science and technology capability, up to a point, complement rather than substitute imported technology.

12. In short, therefore, the current focus is on taking advantage of opportunities for complementing local technological capabilities with technology obtained either as part of investment flows or through other conduits for technology transfer. At the same time, there has been a growing recognition that the enterprise is an extremely important entity for accumulating technological capacities in developing countries. The way technology is perceived has also evolved. It is viewed as a complex product and its development and assimilation demands interaction between various sectors in the economy. In this respect, the modern view of technological advance is at considerable odds with a linear thesis. Instead of an inevitable sequence from basic research through directed basic research, experimental design, applied development to pilot project and full-scale production, each stage often influences the others in a multidirectional fashion. Furthermore, there is a rich and complicated network of linkages through which various agents transmit and receive technical information.

13. The "developmentalists" have never been comfortable with the historical analysis of conventional economics. Indeed, there has been a growing consensus among development economists that the nations that are now attracting more

robust flows of technology are the ones that have taken prior actions to upgrade their domestic science and technology base through establishing incentives and an economic environment conducive to innovation developing adequate levels and categories of human resources and providing appropriate institutional, infrastructural and real-services support. Furthermore, they are able to endogenize and gain more benefits from the imported technology. This highlights the importance of the historical development of technology both at the enterprise and national level, a fact that serves as an incentive to begin putting one's scientific and technological house in order.

14. In addition to the foregoing shifts in emphases, or in some cases, fundamental changes in the way certain aspects of technology and development are viewed, there is significant interest in the current literature on the actual and potential impacts that newly and emerging technologies might have on developing countries. Significantly, low-income regions are not being completely neglected in these areas.

Chapter II

Technological capacity-building

A. Technological capacity-building (TCB) in developing countries by enterprises

15. Over the years, research on several industries has convincingly demonstrated the ability of enterprises in developing countries to innovate by using in-house know-how and resources. While most often such innovations are based on incremental improvements, and while ordinarily an individual change adds only slightly to efficiency, the cumulative effect can be a powerful source of enhanced productivity. Experience has shown that some enterprises in developing countries are capable of more significant technological learning and even major infusions of technology. Naturally, all enterprises do not show a proclivity or capability for innovation; however, there has been a sufficient number that do, thus drawing more attention to the process of enterprise-level learning.

16. One useful framework for examining enterprise-level technical learning is the concept of the "learning ladder". Each rung in the ladder depicts the progression in the learning process, starting from the ability to recognize an opportunity for technological input, the capacity to seek and select the appropriate technologies, the ability to adapt to local conditions, the skill to modify technologies, the know-how to generate new processes and products, and finally, the capacity to undertake R & D at the enterprise level. In reality, however, this progression is not inviolate and the available evidence indicates that there is a discontinuity in the learning process which makes it particularly difficult for most enterprises to go beyond the modification stage.

17. More detailed investigations into technological capacity-building at the enterprise level have revealed additional complexity. For instance, there is a profound influence on technological behaviour depending on the type of industry within which an enterprise operates. Sources of technology, direction of technological effort, the opportunity and room for technological manoeuvring are evidently conditioned by intersectoral differences.

Intra-enterprise learning

18. The neo-Schumpeterian school of economics, which has made the most effective attempt to address the question of how the enterprise uses and integrates technology within existing knowledge, has found it necessary to transcend the restrictive assumptions surrounding neo-classical versions of innovation. A major building block is the proposition that some technology, whether embodied in capital equipment or conveyed through licences, patents, books, word-of-mouth, etc., is often "tacit" or not fully codifiable.

19. The difficulty of codifying all technical knowledge is the primary reason why viewing technology as a commodity is misleading. While some technical information can be fully transmitted by word of mouth, printed matter or observation of practitioners, many forms of important technologies incorporate various degrees of tacitness requiring post-acquisition effort on the part of

the receiving enterprise. A second fundamental aspect is that enterprise-level learning tends to be "localized" by centring around deviations from known modes of production and searching for rules that have been successful in the past. Also, it tends to be cumulative in the sense that past learning experiences pave the way and condition the directions for future technological undertakings.

20. As a consequence, mature firms can have diverging paths of search and innovation, a result consistent with observed differences in intra-industry productivity levels. More importantly, given a few plausible assumptions, multiple equilibria outcomes are possible for enterprises depending on their past learning efforts and the technological and economic environment. Unfortunately, this includes the possibility of being locked into a low innovation situation.

Linkages

21. While some interest in backward and forward linkages among productive entities in developing countries appeared in the early literature, it was not until the 1980s that attention began to be drawn to the various channels through which enterprises in developing countries could access technical information. These learning mechanisms, many of which to one degree or another combine interpersonal relations with commercial activities, have become increasingly appreciated as a key element in capacity-building. Among the most common linkages described in the literature are: (i) subcontracting and other sourcing mechanisms; (ii) work force mobility; (iii) equipment suppliers; (iv) user-producer relationships; (v) linkages with R & D and other supporting institutes; (vi) consultancy services; (vii) Informal linkages; (viii) strategic alliances which may involve linkages with government, university or private R & D institutions; and (ix) intra-enterprise linkages.

The State sector

22. The available evidence on the role of the State sector in accumulating technological capability shows rather a mixed picture. While there are several cases of public enterprises that have accumulated considerable technological prowess, there are also others that have exhibited only moderate success and still others where the record has been dismal.

Small and medium enterprises

23. Small and medium-sized enterprises (SMEs), in developed countries are receiving a great deal of attention, perhaps because of the dynamism this sector has exhibited over the past decade. Unfortunately, however, relatively little is known about technological progress and the process whereby technology is acquired and mastered by SMEs in developing countries, particularly as regards the larger SMEs of the formal sector.

Linkages to external sources

24. Among the most obvious observations that can be made about enterprise-level technological capacity-building in developing countries is that foreign sources of technical learning are extremely important to the enterprises in

these countries. Firm-level acquisition of technology involves, to some extent, technology from abroad and frequently the technical information secured from foreigners is crucial for continued technological progress of the receiving enterprise. Every type of linkage discussed above frequently has an international connection and involves investment flows. In particular, direct foreign investment is a common conduit through which learning linkages can be activated.

25. Experience shows that building technological capability under developing country conditions is not easy. In many cases it has not been possible to acquire technological capacities that go beyond learning passively from production activities. The success of technological capacity-building depends on deliberate efforts backed by favourable industrial policy. As can be deduced from the experiences of successful countries, a proactive approach to enterprise-level technological capacity-building appears to be a prerequisite to achieving technological dynamism.

B. National measures for technology capacity-building in developing countries

26. Although the literature on technological capacity-building has recently begun placing greater emphasis on the enterprise level, a nation's technological capacity-building or competitive position is just the sum of individual firms' technological capabilities. Technologically progressive enterprises operate within a rich network of interconnections between themselves and other institutions. In addition, the general economic environment plays a significant role and as is the case with enterprises, history counts for nations as well. This can be seen, for example, in the different evolutionary paths that various developed countries have taken in terms of science, technology and education.

Macro-economic policies and technological capacity-building

27. Bearing this in mind, what are the specific conditions at the national level that can facilitate technological capacity-building? Three sets of conditions are identified in the literature. The first concerns conditions that are not specifically directed at science and technology policy as such but are deemed desirable for the overall operation of the macroeconomy. Adequate economic growth, political stability, stable prices, high levels of employment and a favourable balance of payments all fall into this category. Other helpful conditions include a dependable and predictable legal system and a general economic atmosphere that rewards enterprises' initiatives and innovative efforts. In this context, access to global technologies is connected with intellectual property rights and a healthy exposure to competition. The later can spur entrepreneurial and innovative energies and talents.

The institutions for technological capacity-building

28. A second set of conditions involves institutions and infrastructures that target technological capacity-building. The possibilities include a high-placed science and technology institute and/or a national council of science and technology set up specifically to formulate technology-related

policies and give guidance to national efforts relating to technological capacity-building. In this connection, the entire educational apparatus, both formal and informal, can play a central role in providing the institutional base necessary for building local technical skills. Moreover, intelligence services can be provided by agencies that gather and make available information on technologies, production, marketing, finance, investment opportunities, and the domestic and global economy. The availability of such data will not only reduce transaction costs for individual firms attempting to acquire information on their own but will also raise the amount and quality of information readily available to them.

29. Other types of support infrastructure include R & D institutes, engineering consulting services and extension services. Often R & D institutes tend to be State-funded, but even in cases where they are not, the State can play a constructive part in encouraging the development of private R & D activities. Extension services can be directed to testing of materials, advising on standards and quality control, counselling domestic firms on negotiations with foreign counterparts regarding joint ventures, licensing arrangements and other similar activities. Although not universally accepted, initiatives such as industrial parks are thought by most to be an effective way of boosting local technological capacity through increased linkages and communications between domestic firms and locally located foreign firms. Other less frequently used measures to induce local research capability include enriched salary incentives for selected R & D projects, tax rebates for R & D activities and tax levies to support R & D.

Specific policy instruments

30. A third set of conditions involves policy instruments that can be used to encourage technological capacity-building. These include import licensing, the foreign exchange allocation system, price controls, concessional credit schemes, investment grants or subsidies, preferential tax treatment, protection through tariff and/or quota measures, and tax exemption on imported capital goods and intermediate inputs. The procurement system of government agencies and State enterprises can also be fashioned to support innovative sectors and new product development.

31. These instruments can be focused on specific sectors or producers, a characteristic that renders them highly controversial. Past experiences show, however, that in order to be effective, these instruments must be applied with consistency and persistence. An agreement needs to be reached on performance criteria with the sectors, industries or enterprises that are being targeted and progress must be monitored. Moreover, the evidence available suggests that it is inadvisable to try to use these types of targeted instruments for other purposes than TCB (e.g., increasing employment, solving balance-of-payments problems, redistributing income, etc.), because the dynamics of cumulative learning can be dampened under these circumstances. Finally, it is widely believed that science and technology policy should be in harmony with trade, industrial investment and employment policies, although beyond a general exhortation, the specifics have so far received only scant treatment.

32. In summing up, therefore, it should be stated that while the literature is liberally sprinkled with descriptions of various policy and institutional conditions necessary for building a technological base, there is a dearth of solid analytical and evaluative material on how effective many of them are in promoting TCB. There are, however, three exceptions: R & D institutes, human resources and intellectual property rights.

R & D institutes

33. Over the years, developing countries have made concerted efforts to boost their science and technology capability and develop indigenous R & D capacity. Despite these accomplishments, however, there is overwhelming evidence to suggest that many research institutes in developing countries are operating far below their potential. There is no question that the central problem with the research system in developing countries is the anaemic contribution that R & D activity provides the productive sectors within these nations. This deficiency is attributed primarily to the weakness of linkages between R & D units and producing enterprises. This shortcoming is at the core of the problem, although there are also deficient linkages in other areas; there is, for example, little organic dialogue among researchers, agriculturists, industrialists, financial institutions, consultants and government decision makers.

34. A number of studies on this subject have also uncovered a variety of problems at the institute level regarding the selection, maintenance and use of laboratory equipment and the sub-optimal allocation of key researchers' time. The literature, furthermore, describes difficulties with the choice of research projects which tend to be too small to attain a critical minimum threshold of resources devoted to individual projects and are, in the aggregate, too heavily concentrated in basic research. Unstable funding for R & D is another difficulty widely mentioned in the literature.

Human resource development

35. Human resource development is one aspect of social development which has received considerable attention and support in developing countries. This is, to an extent, due to the direct link that exists between the development of human resources and the building of technical capability.

36. The literature identifies at least four major trade-offs in developing human resources for technological capacity-building. The first is related to the controversy involving the proper role and balance of secular and religious authorities in providing education. Second, there is the conflict between suffering the costs of "brain-drain" and allowing educated citizens to choose their own destiny. Third, for a given education budget, there is a trade-off between provision of low-skill and high-skill education; in practice, it has proved easier to expand university education than secondary education, although this has been questioned on economic grounds. Fourth, there is the problem of finding a proper balance between acquiring technology from abroad and gearing human resource development to endogenization vis-à-vis generating technology de novo domestically. Several studies have stressed that to a

certain extent these activities can be complements rather than substitutes; if so, the question one ought to ask is how can the educational system in developing countries be designed to achieve the necessary balance?

Intellectual property rights

37. The 1980s saw heightened interest in the international aspects of intellectual property rights (IPRs). Developed countries' interest in this topic is attributed to three factors: (i) the rapid growth of international trade in knowledge-intensive goods and services in recent years; (ii) the new opportunities created by global economic liberalization for exploiting proprietary technologies, and (iii) the improvement in the technological capacity of some developing countries which has increased the risk of imitation of technologies developed in mature industrial economies.

38. The concern shown by developed countries, along with the fear of retaliatory actions against nations thought to have weak IPRs, has forced developing countries to take a closer look at the overall economic consequences of providing more secure protection for intellectual property. In addition, there is evidence to suggest that as developing countries accumulate more advanced technology, some are becoming increasingly conscious of the benefits of protecting their own intellectual property.

39. The benefits to developing countries from strengthening their patent protection identified in the literature include access to information disclosed in patents, stimulation of domestic research, enhanced technology and foreign direct investment inflows, easier access to markets in developed countries, and the stimulation of more R & D globally.

40. Possible costs include the expense associated with administering and enforcing the new regulations, increased payments for proprietary knowledge, and higher domestic prices in the short run due to anti-competitive elements associated with IPRs. Restrictions on copying could also have an impact on employment, foreign exchange earnings, industrial output and the process of learning through imitation or "reverse engineering". It must be stressed, however, that the conceptual and empirical investigation of the effects of IPRs on developing countries is still in its infancy. There is little agreement as to the net effect of the benefits and costs just mentioned and some believe that IPRs should be lax for LDCs and become stronger as one moves toward the NICs.

Chapter III

Technology, competitiveness, industrial policies

A. Enterprise-level strategies for attaining and maintaining international competitiveness

The conceptualization of the firm

41. In the literature discussing international competitiveness, one definition of a firm which is receiving increased prominence is the conceptualization of the firm as a collection of core "competences". Core competences are those abilities which give the firm a competitive advantage and facilitate the realization of value. Thus, the condition of being competent is equated to that of being competitive. Accordingly, the corporate strategy or policy priority of managers is to identify the firm's core competences and to concentrate on developing them in order to improve competitiveness. However, the proponents of the "competence" concept stress that core competences cannot be acquired quickly or easily or at lower cost or transferred to others, and it is precisely this feature that makes them a source of competitiveness. A firm is able to earn an economic rent from those competences which are in short supply and cannot be readily and inexpensively emulated by would-be competitors.

42. The above concept of competence has important implications for the conceptualization of corporate strategy since a firm is constrained in what it can do by its competences and the limitations it faces in acquiring and accumulating them. This view, however, is in strong contrast to the "voluntarism" evident in much of management literature, where the impression is often given that the key to success lies in managers developing an appropriate strategy. The "competence approach", on the other hand, suggests that although strategy is constrained by competence, good strategy is based on identifying and enhancing distinctive competence. The strategic imperative for management, therefore, is to identify simultaneously the firm's distinctive competences and the markets in which these competences can be used to earn satisfactory economic rents.

43. The literature is now beginning to tackle questions on how competences emerge, accumulate, or yield value, i.e., how they are organized, and what factors need to be taken into account in their organization. So far, most of the work that has been done in this area relates to some notion of "bounded rationality". The term refers essentially to the constraints that limit the individual's ability to process information, implying logically that individuals have no option but to make decisions on the basis of the information they have processed, rather than on the total amount of relevant information in existence. However, while bounded rationality is an important consideration to take into account in organizing competences, there are many other factors that need to be explored in a more systematic way if we are to better understand and, therefore, design the forms of organization that are appropriate for the development and exploitation of competences.

Organizing the accumulation of competences

44. At the firm level, the important question is whether a firm needs to be subjected to the pressures of a competitive environment in order to develop competitive core competences, and if so, what kind of "competition" is necessary? In this respect, it is important to distinguish between competitive "pressures" and competitive "incentives" because of their different effects. It is argued that while competitive incentives carry the promise of the firm and (some or all of) its members being better off, competitive pressures carry the threat of being worse off. Whenever greater weight is attached to being worse off, competitive pressures will have a greater impact on a firm than competitive incentives.

45. Literature concerning the firm has traditionally dealt with firms operating in developed-country markets which, under international trading practices, are usually relatively open so that competitive pressures may, in both factor and product markets, come from other firms producing domestically or from imports. In this context, the very concept of core competence implies the existence of significant competitive pressures. The situation in many developing countries, however, with smaller markets and often significant trade barriers, is very different.

46. Much of the earlier literature on the NICs has argued that their superior performance resulted from their introduction in the 1960s of a trade regime that approximated free trade. More recent literature, however, has pointed out that both Japan, in earlier periods, and the NICs have eluded many of the precepts of neo-classical thinking. This has led to a growing body of literature on how manufacturing-based and export-oriented trade policy was used by these countries to create the incentives necessary to accumulate competences while fostering the competitive pressures needed to ensure that these competences are "competitiveness compatible".

47. The above discussion on the importance of competitive pressure for the accumulation of core competences makes it implicitly clear that in order to understand the processes that go on within the firm (such as the development of competences) it is necessary to understand the environment or context within which the firm exists. Accordingly, an analysis of the interior of the firm requires simultaneously an analysis of its exterior or, as sometimes referred to, its "selection environment". The latter refers to the sum total of factors which influence growth of the firm.

B. Strategic intervention: technology, competitiveness and industrial policy

48. In the developed economies, industrial growth and international competitiveness usually depend on access to new technologies and the capacity of different countries to sustain their lead in innovation and technological development. It is therefore not surprising that since the early 1950s much of the discussion on technological capacity-building and competitiveness (at the government and academic levels) has centred around the impact of policy, that is, whether or not an active industrial policy is necessary to achieve technological leadership and improve the competitiveness of national companies.

49. Basically, the debate has been between two elements: on the one hand, those who argue for minimum intervention and believe that far from stimulating technological development and inducing competitiveness, strategic intervention by means of industrial policy stifles competition; and on the other, those who advocate an active industrial policy to support technological development and competitiveness.

The non-interventionist position

50. According to non-interventionists, the type of industries and technologies developed should be determined not by government policy but by the market. Following neo-classical economic doctrine, they argue that the role of the government should be confined to creating the right conditions for competition and the market to function properly. Competition between firms is believed to be highly desirable because it leads to efficient production at a minimum cost and creates an environment conducive to technological change and innovation. Consequently, anything which interferes with competition is viewed as undesirable.

51. Following this logic, it is further believed that collusion and/or cooperation between firms invariably constitutes a threat to competition. Firms, it is argued, have an interest in colluding in order to restrict competition (whether their collusion is explicit or implicit). While this will benefit the firms affected by pushing up prices and possibly increasing revenues and profits, it is the consumers of their products who will lose. Thus anti-trust regulations have been prominent in the United States and other developed countries such as the United Kingdom and Germany, being intended to minimize the opportunities for inter-firm collusion or cooperation.

52. Indeed, the differences among industrial-policy approaches in Japan and other major industrialized countries are reflected in the differing level of importance attributed to laws regulating competition. In Japan, inter-firm cooperation in the field of technology and marketing is not only tolerated but also encouraged through forward-looking industrial and research policy. The central objective is to identify strategic industries, key technologies and potential markets for public assistance through direct and indirect measures. Many attribute the Japanese success to this approach.

53. Non-interventionists argue, however, that the Japanese model will not work in the Western-style market economic system, pointing out that it would restrict the role of the market. Moreover, even if adopted as a strategy, accurate predictions with regard to the development of key industries or the identification of successful markets are not as easy and straightforward as claimed by some pro-interventionists. Mistakes are possible and if investment decisions are made on the basis of wrong forecasts, commitments by entire branches of industry can turn out to be bad investments. Thus Japanese-style strategic intervention by means of industrial policy to foster technological development is seen by some observers to be inappropriate and unworkable in the developed economies of the West.

54. Another argument used in recent years to reject strategic intervention by means of industrial policy concerns the globalization of production, growing foreign direct investment and the expansion of cooperation or alliances

between firms of different countries. It is estimated that during the 1980s the world stock of foreign direct investment doubled, reaching over a trillion United States dollars by 1990. Furthermore, since the mid-1970s, there has been at least a ten-fold increase in the number of inter-firm agreements in technological cooperation, most of them between firms of different nationalities.

55. These trends, it is argued, have blurred the national origin of both products and firms, thereby severely hampering strategic intervention to assist national firms, in exclusion of other firms originating from other economies. The greater the level of direct foreign investment and cross-border corporate alliance, the argument goes, the less effective strategic industrial policies will be in enhancing the international competitiveness of national companies. Policies, even if they are targeted, accordingly tend to benefit foreign firms as well, thereby neutralizing any advantages national firms may have enjoyed.

The pro-interventionist position

56. For pro-interventionists, the issue of technological development is intrinsically linked to competitiveness. Access to new technology will enable countries to sustain their competitiveness. By the same token, however, technological dependence can lead to loss of competitiveness. Not surprisingly, therefore, calls for an industrial policy in recent years have come largely from academics and politicians who are concerned with rapid technological advancement in competitor countries.

57. In Europe, for example, there is concern about the fast development of new technologies (i.e., information technology, biotechnology, energy and space technologies) in Japan and the United States and the fact that Europe lags behind in these areas and will soon become dependent on imports from these countries. It is argued that technological dependence on key technologies such as computer memory chips can lead to loss of competitiveness not only in industries that are engaged in the manufacture of computer hardware but also in other industries where these technologies are applied. Consequently, advocates of the interventionist approach warn that without active government policy directed at these key technologies, national firms will be subject not only to unfair foreign competition but also to an irreversible weakening of their technological capacity.

58. Similarly, in the United States calls for industrial policy are linked to the perceived deterioration of that country's industrial competitiveness, especially in comparison with that of Japan. The source of this problem is the continuing relative erosion of American strength in high-technology industries.

59. In summing up, therefore, the available evidence suggests that although many developed countries have used industrial policy at one point or another, either to protect/preserve old industries or as a response to new industrial problems, only a few have used it consistently. In recent years, however, the loss of competitiveness arising from new technologies has forced most developed countries to focus on to a set of principles that broadly favour strategic policy intervention in key sectors. In the case of developing

countries, on the other hand, the industrial policy debate has revolved around the infant-industry argument and in particular the question of how and for how long emerging industries should be protected.

C. Strategic intervention: the debates over infant-industry protection and industrial policy

60. Arguments for and against infant-industry policy are too numerous to include in this summary. However, two important points arise from this debate:

61. First, few would recommend the old style import-substitution industrialization model as a long-term route to acquiring technological capacities. It has been demonstrated that costs of the import-substitution industrialization model were extremely burdensome: agricultural and traditional export sectors suffered; excessive capital intensity was encouraged with detrimental impacts on employment and income distribution; import-substitution industrialization became import-intensive; underutilization of capacity was common; and the protected "hothouse" environment did little to encourage efficiency.

62. There are some authors, however, who argue that the problems accompanying ISI have little to do with import-substitution industrialization per se. They point out that the problems are related to external factors and the way governments manage (or mismanage) import-substitution programmes. In this respect, reference is often made to the fact that virtually all industrial nations developed their manufacturing sectors behind protective barriers in their early stages.

63. Another generalization that can be made is that despite widespread acceptance of the virtues of a healthy export sector and heavier reliance on market forces by most developing countries, the literature reflects a major revisionist trend away from the pure forms of neo-liberal policy prescriptions that prevailed at the beginning of the 1980s.

64. Thus, as reflected in both literature and real-world policies, there is widespread dissatisfaction with both import-substitution-industrialization and a pristine form of neo-liberalism as a means of accumulating technological capability. Between these two poles, however, the number of possible permutations for strategic interventions is somewhat daunting. In its simplest form, the objective of infant-industry policy is to temporarily shelter young, high-cost domestic industries from mature, low-cost competition from abroad to provide time for the protected national industry to gain the technical expertise to lower costs to an internationally-competitive level.

65. This approach for intra-industry learning has been roundly criticized on several grounds. It has been argued, for example, that it is not easy to predict which industries have the capability of becoming low-cost in the foreseeable future. Moreover, it is pointed out that since the world technological frontier is likely to progress, the infants are chasing a moving target which means a more rapid cost reduction is needed or a more extended

period of incubation is required. In addition, the private sector is capable of sufficient foresight to pick winners and cash in on future gains after an initial period of losses.

66. There is also a political-economy argument which says that in actual application, the argument for infant-industry is misused to disguise unjustified avoidance of international competition and also that the protection granted very frequently is kept in effect long after an industry reaches adulthood. Furthermore, the perception that protection is de facto long term may blunt incentives for acquiring the technical learning to become globally competitive. These practical aspects led, even those who recognized the validity of the infant-industry argument, in principle, to become very discouraged about its actual employment.

67. Although some developmentalists have defended the validity of temporary protection for stimulating intra-industry learning, pointing out that in a developing-country context the private sector may be excessively averse to taking risks, inadequately informed or unable to obtain funds because of imperfect financial markets, this more constricted version no longer enjoys widespread support. There is, however, a general agreement that the existence of benefits that spill over into segments of the economy beyond the protected industry are a prerequisite for defending intervention on behalf of immature industrial activities. There is also the suggestion that, since R & D and most other innovational activities require time, involve risk and absorb resources, and since, in the early stages of accumulating experience in generating technology, such undertakings are likely to be high cost, there may be a case for fostering domestic TCB through protecting technology-related efforts as well as sheltering the production of final output.

68. What has been the result of infant-industry protection policy? More concretely, it can be said that infant-industry protection is very difficult to bring off successfully. The record is strewn with cases where results clearly did not warrant the sacrifice. Second, frequently the period of time required for the successful maturation of some infant industries can extend to decades. Although there are some difficulties involved in specifying a precise beginning and maturation of an infant industry, there are reasons to suspect that the required length is growing as technologies become more complex.

69. In this connection, two important lessons drawn from studies on these issues are worth mentioning. First, it is a mistake to cut off access to outside technology when the world technological frontier is moving very rapidly. Second, a key concept in the whole process is selectivity. There must be some selection of products or product areas to target.

70. The question of governments' ability to learn and shift policies accordingly is an issue which has received greater attention in the literature. In this respect, the evidence emerging from the newly industrializing countries has shed considerable light, especially as to why infant-industry protection is a risky business and why the period from infancy to maturity can be so lengthy. The evidence obtained suggests that there are a number of balancing acts and intricacies involved. Among other things, they require learning to ease up on purely regulatory functions and shift to a more

positive, handmaiden-oriented or nurturing position. For many governments this may not be easily accomplished. There is also the matter of degree, and as always, selection, with regard to how much and what kinds of technology to import. In addition, conditions will change through time requiring sensitivity and subtlety in responding to them. The difficulties inherent in government learning may go a long way in explaining why countries that have already attained a semi-industrial status seem to have a better chance at carrying an infant industry through to maturity. For the vast majority of developing countries, this is additional cause for not taking the initiation of an infant-industry lightly and, on a case-to-case basis, to weigh carefully whether suffering the costs of market failure might not be the wisest course.

Chapter IV

Technological strategies for the least developed countries (LDCs)

71. Turning to the issues faced by the LDCs, our knowledge about workable technological strategies becomes increasingly inadequate. The review of literature on the general technological situation in the LDCs and poor regions in other developing countries brings out the well-known constraints they face: low level of human resource development; inadequate infrastructure; low demand for technology resulting from small and weakening manufacturing sectors, small market size, reliance on relatively capital-intensive production processes, policy bias towards large-scale enterprises, and the tendency for domestic production to duplicate imports, a condition which has been characterized as "import replication", as opposed to "import substitution".

The importance of the informal sector

72. In view of its importance to the economies of LDCs, the informal sector has been the focus of a number of studies on technological behaviour. The findings contradict the notion that the micro-enterprises making up the informal sector are stagnant in terms of technology or capital accumulation. Indeed, technological capacity is manifest in diverse forms, depending on the geographic area and the consequent contextual situation in which firms operate. Technical learning and capital accumulation tend to go hand-in-hand, seeing that the accumulation of capital equipment (more expensive and complex at each stage) requires parallel learning by workers and small-unit managers - it is analogous to the cumulative nature of technical learning in larger firms.

73. In the informal sector, ideas for innovations come from many sources including imagination of the owner, friends and neighbours, and observations by informal or formal sector users or equipment suppliers. Surprisingly, while subcontracting arrangements may spur innovational activity, numerically they are not very important. The same holds for information secured from government agencies. By contrast, however, education seems to have some positive influence although training and years of experience are much more significant in explaining different incidences of innovation among firms. A great deal of this experience, both for the entrepreneurs and workers, has been acquired during previous employment in the formal sector.

What types of technologies?

74. The scant success of traditional development strategies in improving the conditions of the LDCs has led to a whole body of literature on what should be the nature of technologies or technological strategies for these countries.

75. The appropriate technology movement has given rise to a significant amount of literature. The concept, which was originally referred to as intermediate technology and gained popularity in the 1970s, has a number of definitional problems. At times the concept is couched in general terms which stress the examination of appropriateness (economic, social and cultural) in each individual situation, but this general-principle approach is so all embracing that it runs the risk of being vacuous. Another approach relies on

specific characteristics as definitional guidelines. As the emphasis of the appropriate technology school is on low-income, labour-surplus societies in which production is normally performed by small-scale units, appropriate technology, compared to conventional technology, would exhibit all or most of the following characteristics: (i) low investment cost per work-place, (ii) the employment of a relatively labour-intensive technique, (iii) the need for low to moderate skill levels and entrepreneurial capabilities, (iv) a usual mode of operation that is ecologically sound, (v) the use of a high proportion of locally available inputs and (vi) efficient operation on a small-scale basis. Naturally, the appropriate or intermediate technology would have to be superior to traditional technology in order to be a viable option.

76. It should be noted, however, that although the appropriate-technology movement can point to many individual successes, there is little evidence that it has contributed much to achieving technological dynamism. Consequently, despite its obvious appeal, appropriate technology has failed to be adopted into the mainstream as the dominant form of technology-practice.

77. The potential of the frontier technology in alleviating poverty has also been the subject of considerable literature. An approach to applying frontier technology in developing countries has been described in the literature under the term technology blending. As suggested by the term, the idea is to discover whether the combination of modern biotechnology, photovoltaics, laser applications, space satellite communications, new materials science and microelectronic innovations can be married with (not replace completely) techniques and procedures found in the village economies, SME manufacturers, the urban informal sector, agribusiness and small-holder agriculture.

78. Technology blending is distinct from appropriate technology in that, compared to the latter, blending is likely to: (i) require greater investment per workplace created, (ii) involve a larger leap in terms of skills, and (iii) require more importing of the technology. While some successful cases of blending have been reported, it is apparent that not all technology blends work well and those that do depend on a specific set of circumstances. In the context of technology capacity-building, in order for "blending" to contribute to technological dynamism, the blends must provide the basis for local innovation by seeking other feasible applications, adaptations to local situations, and further improvements and refinements. However, as initiatives with technology blending are in early stages of planning or implementation, evaluations are not yet readily available in the literature.

79. Concerning frontier technologies, a number of studies have reported on computer use and information technologies in Africa and the problems faced in the application of these technologies. Despite the difficulties noted in their application, one aspect of computer technology in developing countries that has attracted some attention concerns the so-called expert systems, which are computer programmes that, by utilizing information and reasoning techniques, try to simulate those employed by human experts. There are serious discussions and pilot projects involving expert systems are being applied to problems of developing countries, primarily to agricultural, forestry and village health care. While the use of expert-systems in developing countries has not lived up to expectations in the 1980s, their

advocates advance several reasons why efforts to continue explorations and experimentations should be encouraged. First there are expert systems in use in developed countries that hold some potential for productive applications in developing countries; second, there are already some promising expert systems in operation in developing countries.

Different institutional emphases

80. Regardless of the mix of technologies selected, they do not operate effectively in an institutional void. While literature generally agrees on the need for new approaches to the technological development in LDCs, the question of what is workable still remains.

81. The literature on what types of institutions or producing units should be emphasized for breathing new technological life into low-income sectors or countries has been an attempt to answer the above question in connection with specific sectors or regions. The various proposals include taking a new look at the potential offered by the natural-resource-based sector. It is argued that this sector, which is fairly large and relatively profitable in many African countries, is amenable to a number of improvements: technological upgrading through the application of new technologies; the establishment of a science and technology institute under the national planning commission that will not only formulate policy but will also oversee its implementation; and institutionalization of arrangements for networking among different actors involved in innovation. The central focus of such arrangements would be on innovation at the enterprise level through collaborative problem-solving involving supplier firms, university facilities, engineering consultancy firms and research institutions; a bigger role for SMEs, including those of the informal sector and in rural areas; and greater use of possibilities offered by Non-Governmental Organizations.

The common ground

82. Turning to the more general issue of the role of technology capacity-building in the process of development, there seems to be a broad consensus regarding the detrimental consequences to capacity-building and industrialization when the gulf between current capabilities and the complexity of the technology in place becomes overwhelming. It is argued that a mismatch between capabilities and the complexity of technology in place does not only lead to industrial inefficiency but also to "negative feedback", i.e., industrial experience rather than providing the stimulus for further development of learning of new skills and capabilities, which creates attitudes and interests that inhibit the full development of other sectors. Thus, pursuing technology capacity-building policy through importation of modern technologies (i.e., "technological fixes") is seen as unviable and myopic. At the same time, however, opinion is virtually unanimous, that the way out for nations, regions or sectors trapped in relentless poverty lies in technological capacity-building. While this may seem contradictory, in the light of complaints about resorting to "technological fixes", there are major qualifications that distinguish the two positions. One difference is that for the former group of authors the process of technological capacity-building is a long-term process. A second difference has to do with what is understood by the term "technological capabilities", that is, whether they are a narrowly

conceived set of technical skills and managerial practices associated with the operation of specific hardware or whether the emphasis is on the accumulation of managerial/organizational technology, i.e., the capacity to conceive a new project, select and negotiate for the technological components required, see the scheme through a construction and completion phase, initiate a continuous stream of improvements, and undertake investments in discrete improvements in technological capacity-building.

83. Furthermore, there is general agreement on the need to put emphasis on local initiative and learning by the indigenous population. Moreover, it is repeatedly emphasized that alternative learning paths have not been explored and even when the "correct" moves have been made, there has been a lack of persistence and seriousness of execution. However, advocating a meaningful and dominant role for indigenous resources should not be confused with a doctrinaire espousal of "self-reliance". The tradeoffs between long-run local learning and short-term exigencies are a matter of judgement and subject to some elasticity depending on practical and pragmatic circumstances; timing and tactics may be manipulated as long as the accumulation of domestic TCB remains the ultimate objective.

84. Not only should the initiative for innovation and technical learning be guided by local institutions, the impetus should originate in the form of demand-pull for innovations from the productive sector. The literature agrees on the pivotal role of the private sector and of the proper orientation and inspiration of local innovations. But while market incentives are vital, they are not sufficient for spurring technological dynamism in very low-income nations or sectors. This view is not surprising since some scholars make the same observation with regard to more technologically advanced countries where clearly national scientific and technological foundations are on a stronger footing than those of LDCs. In essence, relying on very rapid exposure to market-driven imperatives, in isolation, is merely another example of a "quick-fix" mentality.

85. Finally, there is general agreement that while the task of technology capacity-building in LDCs will not be easy, it is not impossible; some combination of prescriptions incorporating patience, heavy reliance on indigenous resources, cumulative learning, and endogenization of technology can begin to turn the tide in favour of technological dynamism in very low-income regions and nations of the world.

Chapter V.

Technology for agricultural development in developing countries

86. There is sometimes an unconscious predisposition among development analysts to regard technology as relating mainly to industry and by implication almost as having little to do with agriculture. Nothing could be further from the truth. But if technological factors are as important in agriculture as they are in industry, it is nevertheless true that they impinge in rather different ways. There are two broad reasons for this. First, agricultural production is inherently more unstable and location-specific than is the case with industry. This is largely because it takes place within the context of natural (biological) systems that continuously evolve over space and time. The second difference relates to the weakness of the market in allocating technological resources efficiently for the small-scale, heterogeneous type of agriculture which is typical of most developing countries.

87. For these reasons, the investment of resources designed to upgrade the technological level of agriculture (particularly for the poor farmer) has traditionally been seen as the business of the public sector, with research being conducted in centralized institutes and its results passed on to the farmer by means of a network of extension agencies. Interesting questions then arise about technological capacity-building since there is a growing realization that capacity building, if it is to be successful, should take place as close as possible to what is the enterprise equivalent in agriculture, the farm.

88. In the 1970s, the predominant mode of thinking in this area was still what was called the top-down or transfer-of-technology model. The view was that new technologies would come from the transfer of good practices from the developed countries with diffusion taking place through community development programmes. The process of diffusion was achieved through the establishment of a number of research institutions, initially through private and bilateral aid and later with multilateral aid. It was in this context that the transfer-of-technology model came very much to the fore as the correct institutional mode for agricultural development. The rationale for this approach in the post-war period was based on the widespread view that developing country agriculture was technologically primitive and that the rapid population growth rates meant a need for new technologies. Similarly it was thought that the problem was not so much one of inefficient agronomic practices as one of technologies that needed to be upgraded. Furthermore, for the first time, plant breeders started applying plant characteristics previously confined to temperate food crops - hybrid vigour and dwarfing to crops grown in tropical countries. The high-yielding varieties (HYVs) that emerged became the bedrock of what is now known as the Green Revolution.

The Green Revolution

89. The Green Revolution best illustrates the transfer-of-technology model, since the initial impetus for it did not come from the national agricultural research systems (NARS) of the developing countries but rather from two international agricultural research centres (IARCS) that subsequently became

the model for the 18 centres that now comprise the Consultative Group for International Agricultural Research (CGIAR) system. Production technologies and varieties for mandated crops and geographical regions were developed in these centres and subsequently passed on to the NARS for applied research and final transfer to farmers.

90. The impact of the Green Revolution has been one of the most discussed themes in the development literature. However, attitudes towards it have altered over time, due to the phases of technical innovation that have occurred and to the emergence of longer-term patterns in the effects observed. Historically, much of initial analysis focused on issues associated with the adoption/non-adoption of modern varieties, the suggestion being that "non-adoption", and therefore failure to benefit from modern varieties, was simply due to the ignorance of smaller farmers. Later analysis suggested that "non-adoption" was the result of the incompatibility of high yielding varieties with prevailing socio-economic patterns and that these varieties were only suitable for a specific set of favourable physical conditions. In fact, some authors have pointed out the problem was not with the technology itself, since when it could be applied efficiently it was highly successful, but that it often did not meet the diverse needs and circumstances of farmers. Part of the problem with the Green Revolution has been attributed to the centralized nature of the research institutes which were involved in the development and diffusion of the technology which did not allow for feedback from farmers, considered crucial for solving basic problems facing farmers particularly those of small farmers in poor regions. Thus, the better understanding of the issues derived from the experience of the Green Revolution has led to a growing emphasis being put on agriculture as a complex dynamical system.

The new approaches

91. More recent research findings indicate that modern strategies have often been a rather crude attempt to deal with what has now emerged as a sophisticated system of resource management; furthermore if science is to provide technology for these complex systems there must be greater understanding of them. The two best known approaches put forward as alternatives to the transfer-of-technology model are the "farming systems research" (FSR) and the "farmer-first-and-last"(FFL) models. The former which has emerged mainly from the IARCs, relies on working with farmers to identify problems and is intended to involve them to varying degrees in a process of change which takes place wholly or partly on the farm. It is argued, however, that the idea of farmers' involvement, which makes this approach a valuable method for addressing farmers' needs, renders its integration into mainstream agricultural research extremely difficult, due to the hierarchical nature of the latter.

92. This has led to the farmer-first-and-last approach, more radical in that it assigns a central role to farmer-generated knowledge. The literature provides abundant examples of farmers' innovations as well of their ability to manage complex environments in a sustainable fashion. However, despite the recognition of the value of farmer-generated knowledge, the full nature of this knowledge system, its desired institutional focus, and the extent to which it can contribute to conventional agricultural research systems are

issues that are still not fully resolved. In addition, it is unclear how the farmers' knowledge system would cope with increasingly new agricultural technologies.

New technologies

93. A counterpart to the growing appreciation of the complexity of agricultural techno-economic relations is a growing concern about the sustainability of developing country agriculture and the contribution of technology in dealing with it. Probably the most widely heralded vehicle in this sense are the competences and capacities associated with recent developments in biotechnology. The potential of plant biotechnologies for agriculture includes a diverse range of techniques which appear to offer real scope for helping solve the problems of developing countries, particularly since they provide potential "tools" to solve agronomic problems which may be highly location specific.

94. However, the scope of accelerated technological change that is associated with biotechnology is so vast and covers such an enormous range of human activities, including the agricultural sector, that it is inevitable that conflicts of interest will arise. As a consequence, a number of authors have been cautious when discussing the impact of biotechnology on developing countries. One reason why biotechnology seems to hold specific problems for developing countries, from the point of view of capacity-building, is that whereas agricultural research has in the past been in the public domain, much of the applied research in agricultural biotechnology has been undertaken in the private sector, chiefly in developed countries. Furthermore, applied biotechnology has often been the result of private sector collaboration with universities. Also, the development of this industry in developed countries is said to be connected with judicial decisions that have granted intellectual property rights to innovators over genetically engineered "forms of life". For these reasons, it is argued, access to new information on agricultural biotechnology by the scientific community in developing countries is relatively restricted.

95. The rapidity with which biotechnology innovations are produced, together with the above-mentioned concerns, have led to increasing attention being devoted by literature to policy options available to developing countries. Integration of biotechnology initiatives into existing institutions has been the policy stance of many major international agencies; collaborative initiatives with existing "pockets" of biotechnological expertise in developing country research systems have been advocated by bilateral aid agencies. At the national level, a number of developing countries have established centres for biotechnology and genetic engineering. It is argued, however, that these initiatives will still be hampered by the same mechanisms and strategies which have been identified as weaknesses in previous vintages of agricultural technology innovation; a number of authors are suggesting bridging mechanisms which will foster technology capacity-building more directly. The suggestions include the targeting of specific "windows of economic opportunity" or exploration of policy lessons from successful experiences.

Lessons to be learned

96. The main lesson to be derived from the literature is that the achievement of technological capacity-building in the agricultural sector is both important and, as in industry, rather difficult. The importance is partly due to the fact that the benefits of the Green Revolution have not impinged on particular regions and classes (especially the poorest). This leaves an economic problem to be solved. The difficulties involved in actually bringing about technology capacity-building relate to the traditional alienation of formal research activities from the real production experiences and knowledge of poor farmers. Hence, the challenge is how to create institutional structures that will both mobilize and enhance these key human resources, while at the same time permitting the benefits of scientific research to impinge where needed.

Chapter VI.

An agenda for further research

97. One encounters no difficulty in locating discontinuities in our stock of knowledge regarding the accumulation of technology capacity-building and the ways technology determines competitiveness. The following suggestions, however, represent a very selective distillation of the possibilities based on the depth of our ignorance, the degree to which knowledge gaps are already being narrowed by on-going investigations, and the extent to which knowledge inadequacies or voids are considered crucial.

Technology and strategic alliances

98. Despite being a relatively new phenomenon, the tendency for large corporations to seek out strategic technology partnerships with other firms, universities, or independent research institutes has attracted considerable attention. Yet, what is unclear are the consequences that these technology alliances may have on the general accessibility of the newly generated knowledge. So far most investigation in this area has concentrated on the developed industrial countries and the NICs. Concerning the great majority of developing countries, however, a number of questions are still unanswered. Will strategic alliances affect the global distribution of technologies and the ability to mobilize them effectively? For outcomes viewed as undesirable, are there reasonable and appropriate ameliorative measures? What advantages can non-NIC developing countries offer in order to be attractive candidates for inclusion (i.e., their private firms, parastatal enterprises, universities or research institutes) in this very potent aspect of economic and technological globalization?

Science and technology policy and cohesiveness with other major policy objectives

99. While the literature exhibits an awareness of the need for coordinating technology and national policy, it is very short on concrete policy recommendations. Three research approaches for increasing the understanding of policy cohesion are suggested. First, it would be very useful to take a retrospective look at where the most extreme conflicts between science and technology objectives erupted when they were not properly integrated into the overall national policy goals. By determining the forms of these policy abrasions, some useful insights might be garnered regarding the nature of coordinating mechanisms. Similarly, an examination of national experiences of those nations that have attempted to mesh policies, covering both successful and unsatisfactory results, should yield some notions of how to carry out a properly functioning process of coordination. Third, there is a place for some theoretical work based on organizational and behavioural aspects of political economy that would at least make a start at establishing a conceptual basis for approaching the problem.

Incentives and support for innovative behaviour

100. Despite the considerable number of instruments being employed, the literature is virtually silent on how effective these instruments are in

achieving their desired objectives. Further work in this area should include the following: first, a taxonomy of these measures, with an eye toward conducting evaluative criteria; second, stipulation of the appropriate criteria for evaluation; and third the assessment of incentives and support measures. For instruments that have proved inadequate, an attempt should be made to determine whether the cause of the inadequacy was in the instrument itself or in its implementation.

Strategic intervention

101. There is feverish research, and consequently a growing literature, on industrial policy in developed countries and advanced industrializing countries. The orthodox neoclassical economists either do not accept a role for strategic intervention, or conceding the rare occurrence of market failure, they insist that government failure inherent in remedial actions will be even more damaging. In contrast, those who see a role for policy intervention argue that progress can be made through selective or strategic intervention in key industries. However, despite increasing calls for strategically focused industrial policy, the literature is still somewhat obscure on certain key issues.

102. The objectives of a research agenda in this area can be stated by a series of questions. If a nation makes the decision to foster technological dynamism through focused, temporary protection, (i) What criteria should be applied in the attempt to pick winners? (ii) What are reasonable, effective performance criteria for the targeted infants industries, and how should they be administered and monitored? What "exit" criteria should be applied, either because the fledgling has matured, or because it is deemed to be stuck perpetually in arrested development? What are the salient variables in the social, economic and political arenas that abet or impede the ability and willingness of governments to identify and react expediently and judicially to changing conditions?

Intellectual property rights, developing countries and empirical investigations

103. There is a highly sophisticated set of arguments, both pro and con, as to the effect of intellectual property rights protection on technology and innovativeness in developing countries. In addition, there is no dearth of empirical studies, although they mainly concern mature industrial countries. What is lacking are solid empirical examinations of developing country experiences with intellectual property rights protection that will, in effect, corroborate or refute the various notional positions presented in the literature. Research areas include the following: (i) in-depth sectoral and case studies analysing the interrelationships among intellectual property rights, investment flows, technology inflows and technology capacity-building; (ii) studies taking into account the various intellectual-property-right categories (e.g., patents, trademarks, utility models, etc.) and variations of the legal stipulations (e.g., ease of qualifying, breadth of coverage, duration, etc.; (iii) the different effects, if any, that intellectual property rights regimes have on countries at various levels of technological

sophistication; and (iv) the degree of manoeuvrability regarding the mix of intellectual property rights applied in the new atmosphere of a more liberalized and open world economy. These studies should focus on developing countries, since that is where the greatest deficiencies in knowledge are found; however, they should also attempt, where relevant, to estimate the varying impacts on royalty and licensing payments, which are of prime importance to geopolitical discussions over international intellectual property rights agreements.

Least developed countries (LDCs)

104. In view of the enormous gaps in our knowledge regarding technology capacity-building and competitiveness, there is a need to pursue research with regard to a number of issues. Literature on the LDCs indicates that they are especially vulnerable to infusions of technology from external sources. The most efficacious ways need to be uncovered for technology importing countries to gain enough expertise to identify desired technologies, including, of course, the associated "soft" technologies.

105. In addition, there is the question of appropriateness of the technology being imported or locally generated by LDCs. In this respect, there is an important role for political-economy-oriented research that identifies policy options available to the international community that (i) can deliver technology on more efficient concessional terms, (ii) are ambitious enough to make a palpable dent in the technological marginalization of many LDCs, and (iii) are sufficiently reasonable and attractive to serve as the basis for a broad consensus by many donor and aid-receiving LDCs.

106. Another issue concerns the appropriate types of science and technology indicators that might be useful for guiding and monitoring technology capacity-building in LDCs. Very little has been done in this regard; a completely different approach to this issue for these countries may be required.

Innovation systems

107. Although today the linear model of scientific and technological advances finds only few defenders, the question remains whether the concept of technology transfer, and even the process of domestic generation of technology, suffers from some vestigial remnants of the notion that the supply of new applied technologies is fairly inelastic with respect to scientific research.

108. The fact that there is ample literature on R & D institutes in developing countries, but far less on other sources of innovation, might be a symptom of the lingering effects of a linear syndrome. The way technology transfer is usually couched in terms of end-of-pipeline technologies may be another indication. Certainly, if one conceptualizes a spectrum of innovational activities, the flow of information and impulses promoting further innovative behaviour are not unidirectional. If the concept is extended to that of an entire innovation system incorporating all of the interconnections and

linkages through which learning takes place, a multifaceted and multidirectional flow of information and impulses materializes. If such a picture is correct, it may mean that, relative to other avenues for generating technological improvements, traditional R & D activity is overly emphasized. It may also mean that there is an unconscious excessive preoccupation with hardware vis-à-vis organizational skills and entrepreneurial talents of the human agents responsible for manipulating technological artifacts. The idea of evolutionary innovation systems is hardly a completely neglected area, but relative to the potential importance of the concept, the research effort appears to be sub-optimal.

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